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Geological Survey of New Zealand.

JAMES HECTOR, M.D., F.R.S.,
DIRECTOR.

REPORTS

OF

GEOLOGICAL EXPLORATIONS

DURING 1874-6.

WITH MAPS AND SECTIONS.

PUBLISHED BY COMMAND.

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ERRATA.

Page 3, line 34—For *Antemonite* read *Antimonite.*
Page 8, line 13—For *copper, glance* read *copper glance.*
Page 11, lines 26 and 32—For *Crystallaria* read *Cristellaria.*
Page 13, line 1—For *altenations* read *alternations.*
Page 13, last line—
Page 14, lines 9 and 13— For *Te Kara* read *Te Hara.*
Page 17, line 2—For *J. Herbert Cox* read *S. Herbert Cox.*
Page 26, line 37—For *crosses—the line* read *crosses the line.*
Page 32, line 19—For *pyllite* read *phyllite.*
Page 38, lines 17 and 37—For *conchithyra* read *conchothyra.*
Page 39, line 19—For *Waiapara* read *Waipara.*
„ line 32—For *tufus* read *tufas.*
Page 47, last line—For *uncomformably* read *unconformably.*
Page 48, line 5—For *unequalities* read *inequalities.*
Page 51, line 2—For *Tinui* read *Tenui.*
„ line 10—For *Mangapakia* read *Mangapakeha.*
Page 53, line 10—For *carbula* read *corbula.*
Page 57, line 9—For *Koeo* read *Kaeo.*
Page 64, line 3 from bottom—For *when* read *where.*
Page 87, line 13—For *Foramenifera* read *Foraminiferæ.*
Page 99, line 15—For *Johnston's* read *Johnson's.*
Page 101, line 9—For *Veniricardia* read *Venericardia.*
„ line 20—For *Anomiæ* read *Anomia.*
„ line 23—For *Ostræa* read *Ostrea*
Page 104, line 12—For *Paniheri* read *Panikeri.*
Page 118, lines 18 and 24—
Page 119, line 24— For *Korinui* read *Koranui.*
Page 121, line 26—For *arears* read *areas.*
Page 154, line 22—For *standstone* read *sandstone*
Page 173, line 25—For *lo calities* read *localities.*
Page 176, line 19—For *comfortably* read *conformably.*
Page 178, line 33—For *Aphorrhais* read *Aporrhais.*
„ line 34—For *Tirgonia* read *Trigonia.*
Page 182, line 19—For *gypseus* read *gypseous.*

PROGRESS REPORT, 1874-76.

DURING the greater part of the period to which the following reports refer, I was absent on leave in Europe, the Department being left under the efficient control of the Hon. W. B. D. Mantell, F.G.S., as Acting Director.

Captain Hutton having been appointed Lecturer on Natural History and Geology in the Otago University, resigned his position as Assistant Geologist, and Mr. S. H. Cox, F.G.S., was selected for the appointment by Professor Ramsay, Director of the Geological Survey of Great Britain, and commenced his duties immediately on his arrival in the Colony on December 3rd, 1874. Before leaving for England in January, 1875, I spent from September to November in the northern district of the Auckland Province, for the purpose of finishing the reconnaisance survey of the geology of the peninsula lying between Auckland and the North Cape, and completing the geological map published in 1866 by an examination of the Kaipara District. I also revisited the Coromandel Gold Field, Kawa-Kawa Coal Mines, and several other localities where fresh information was to be obtained through the progress of mining enterprise.

COROMANDEL.

My chief object in revisiting this locality was to collect any further evidence which had been disclosed concerning the relation which the auriferous rocks bear to the volcanic series. I first inspected the great Tokotea Tunnel, which is being excavated through the mountain range between Coromandel and Kennedy Bay, in the hope of cutting in a low level the auriferous veins that are worked on the crest of the ridge. This tunnel enters more than half way up the range, but could be reached by a tramway with an easy gradient. The distance driven from the west end at the time of my visit (30th September) was 1,360 feet, through belts of soft tufaceous rock and fine-grained breccia, containing much pyrites with occasional hard bands of hard silicified tufa without pyrites. These rocks are evidently stratified, and the bedding, though obscure, shows a prevailing dip at 50° to 70° to the N.E., or into the hill. At 600 feet from the entrance a fissure was cut, filled with pipeclay, containing pebbles of quartz. This fissure is nearly vertical, and strikes in a N.W. direction, its eastern wall having irregular leaders of quartz containing gold. Beyond this point the character of the rock passed through was entirely changed to a compact greenstone, cut by quartz veins, followed by hard grey tufanite (Propylite of Richtofen), highly charged with pyrites in minute grains. This rock gradually passed into a compact dark purple porphyrite.

The old workings at Kaipanga enabled me to trace the same boundary between the breccia rock and the solid tufanite, in the vicinity of which the richest reefs are developed, in a south line to Kevin's Point; and at this place the deep workings of the Union Beach Company, which extend beneath the sea, enabled me to ascertain that the auriferous reefs are chiefly in the fine-grained silicified breccia, which on the west side the workings are cut off by vertical dykes of andesite, associated with highly inclined beds of dark-coloured tufaceous breccia. Unconformably upon the denuded surface of those beds is a massive conglomerate of subangular and rounded masses of trachyte porphyry, tufanite, and other rocks in a tufaceous matrix, and towards its base beds of laminated clay, containing masses of silicified wood and seams of lignite. This formation forms high, bold cliffs on the north end of Bissel's Island, and corresponds to the Trachyte series of Wangarei and the north, while the Greenstone and Tufanite series must belong to a still earlier period, as I formerly indicated.—(Geol. Reports, 1870-71, p. 93.)

WANGAROA.

A few days was devoted to the re-examination of the coal-bearing strata exposed in the district. The general structure of the country has already been described (Geol. Reports, 1872, p. 153), and the only additional point discovered was the existence at Kaeo River of the green-sands, with the characteristic fossils of the covering beds of the coal at Kawa-Kawa and elsewhere, and that these are separated from the underlying Inoceramus beds of the Amuri series by beds of quartzose grit.

KAWA-KAWA MINE.

This mine, which extends by underground workings for 1,800 feet along the strike of the coal, was found to be in a satisfactory state, and the quantity of coal available with the existing shafting was esti mated at 500,000 tons.

Evidence was obtained that the fault, the existence of which was indicated in my former report and plans of 1866, will not prove a serious obstacle to the future extension of the mine. There is also reason to expect that the green-sand will prove to be a local or false roof to the coal seam, and that, as it is followed to the dip, a hard, gritty sandstone will be found to intervene, which will greatly facilitate the workings, and most probably also improve the quality of the coal.

OHAEAWAI MERCURIAL SPRINGS.

These are springs, and steam escapes at the terminal end of a stream of scoriaceous lava that has proceeded from the conical hills on the south side of the Omapere Lake, which, from its relative level, must be the source of the springs. The springs deposit a brown sandstone, which forms laminated beds 10 feet to 15 feet in thickness, as exposed along the banks of a small stream. This sand, which is an incoherent granular siliceous deposit, includes fragments of the surrounding vegetation, and thin layers of cinnabar sand and globules of metallic mercury.

The layer of the sandstone containing mercury is only 4 inches thick, and is confined to a very limited area, and the attempts made to collect the mercury have not hitherto been profitable.

KAIPARA DISTRICT.

The examination of this district commenced at Mahaurangi, thence to Mangawai and the Port Albert settlement, and from Wangarei to the Wairoa and the northern branch of the Kaipara, returning to Auckland by Helensville.

The youngest formations in the district are seen at Komiti Point, Middle Kaipara, where earthy and tufaceous clays, underlying the trachyte breccias, contain a variety of lower miocene fossils, such as— Cardium spatiosum, Var. gracilis n. sp., Natica solida, Struthiolaria spinosa n. sp., Dentalium solidum, Cassis muricata n. sp.

These rest unconformably on grey marls and chalk marls with plants, and these upon dark green-sands, with Panopæa, Myacites, Aporrhais, Cardium brunneri, and other fossils of the Upper green-sand that forms the roof of the coal.

In the eastern part of the district south of Wangarei there is a limestone and marl formation that represents the Nummulite Group, both from the fossils and also from its position, as, for instance, at Morrison's Caves, behind Waiapu, where the limestone rests unconformably on the green-sands, the marls not being present.

The next lowest beds are the Amuri Inoceramus clay marls and the bituminous shales, which are well exposed at the head of the middle arm of the Kaipara, near Mr. Rye's station.

At Marehenua and elsewhere dykes of dark basaltic rocks cut the chalk and grey marls, and at Tokotoko and Mangarahau, trachyte porphyry and quartzose trachyte immediately overlie the green-sands and marlstones, the Komiti beds not being present.

At the base of the Inoceramus rocks and bounding them on the east, is a great thickness of dark, compact grained sandstone and thin coal seams, which may be studied at Mahurangi, representing the Mataura and Putataka formations; but the Tangahui Range, on the east side of the Wairoa, is composed of greenstone slate, compact greenstone, and green breccias, which appear to form an upper part of the formation. The lowest rocks seen in the district are dark blue and grey slates and sandstones, with strong veins of quartz and manganese ore, similar to that from Kororika Peninsula, Bay of Islands. A strong outcrop of the manganese ore may be seen on the top of the range between Waiapu Valley and Morrison's.

The following may be then given as a summary of the formations of the foregoing district:—

Pliocene.—1. Lavas of Ohaeawai and plastic clays.
Lower Miocene.—2. Komiti beds and trachyte breccias (Taipos of Wellington Province).
Upper Eocene.—3. Nummulitic limestone—Trachyte porphyry and andesite.
Cretaceo-tertiary.
4. Grey and chalk marls.
5. Green-sands and coal grits.
6. Inoceramus clay and Greenstone trachyte and breccia.
Jurassic.—7. Mahurangi green sandstones.
Trias.—8. Mangarakau sandstones and slates.

The following is a resumé of all work which has been carried on by the Geological portion of the Department during my absence, in as condensed a form as possible.

In January, 1875, when I left the Colony, Mr. McKay had not returned from his survey of the country between Cape Kidnappers and Cape Turnagain, which, however, he did very shortly after I left.

He found during this trip further extensions of the Inoceramus beds of the Poverty Bay and East Cape District, cropping out on the sea coast at various points.

Above these the cretaceo-tertiary beds were seen, lying apparently unconformably upon them. They consist of green tufaceous beds and blue clay marls, with turbinolia, etc., the nummulitic limestone forming the highest member of the series.

Overlying the nummulitic limestone a calcareous sandstone is seen, which is, to all appearance, the equivalent of the Taipos, and a direct sequence can be traced from these beds as follows :—

1. Conglomerates.
2. Sandy clays.
3. Coarse conglomerates.
4. Napier limestone.
5. Blue sandy clays and soft grey sandstone.
6. Marly beds.
7. Brown quartzose sandstone, with concretions.
8. Calcareous sandstone.
9. Nummulitic limestone.

The survey of the Raglan District went further to confirm the conformity between the cretaceo-tertiary beds and those of more recent date; a direct sequence was traced from the *Leda* marls, green-sands, and overlying Papakura limestone (with Pecten hochstetteri) to the clay marls, Aotea sandstone and Kawhia limestone of tertiary age, which appear to be the equivalents of the Taipos. The Waitemata beds, as developed at Mercer, also appear to be the higher beds of the *Leda* marls.

At Wangaroa north, brown sandstones, with green sandstones and shales underlying them, in the latter of which thin bands of coal occur, are seen, which the fossils place as the higher beds of the cretaceo-tertiary series. The Inoceramus beds are also developed to a considerable extent in this neighbourhood.

In the vicinity of Napier, beds overlying the Pohui limestone have been examined between Pohui and the sea, showing the following sequence of rocks:—

1. Loose brown sands.
2. Shell (Napier) limestone.
3. Brown calcareous marly sandstone.
4. Calcareous sandy marls.
5. Conglomerate.
6. Blue sandy marls.
7. Pohui limestone.
8. Glauconitic sands.

The upper beds containing fossils, which seem to place them in the same horizon as the Upper Wanganui beds.

The country has been traversed between Napier and Poverty Bay, and, as the work there does not entirely coincide with that of Mr. Percy Smith (Trans. N. Z. Inst., Vol. IX., p. 565), it will be necessary to make one or two remarks concerning this discrepancy.

Mr. Smith appears to have been mistaken in considering the blue marls which occur along the coast line as the highest members of his Papa rock. From these marls Mr. Cox has obtained the characteristic fossils of the *Leda* marls, and the anticline and subsequent syncline, which he has shown, and which Mr. Smith does not seem to have noticed, as existing between the sea coast and the Waikare Moana Lake, fully accounts for their occurrence there.

They are probably, as he regards them, the equivalents of the blue marls which immediately overlie the calcareous sandstone and gritstone of the Waikare Moana Lake.

Mr. Smith mentions an unconformity between his middle and lower Papa Rock, and this would better agree with what we know of New Zealand geology, if his "Middle marls" were considered to be the highest, as shown by Mr. Cox.

We are greatly indebted to Mr. Smith for his map, the boundaries of the formations on which are necessarily far more exact than any we have been able previously to obtain with hurried surveys and imperfect maps; and his observations are of the greatest value.

Down the West Coast of the Middle Island the Kanieri series have been examined, and collections made from them, and also from certain dark coloured greensands which occur below the marls at Calaghan's Hill.

COAL MEASURES.

With reference to the coal measures, these have been examined at Reefton, Abbey Rocks, and Jackson's Bay, and also in the section between Westport and Greymouth, but no cause has been seen to change in any way the classification of these beds.

The description given of them between Brighton and Greymouth by Mr. McKay appears to be perfectly reliable. The position which the seal rocks hold in this section is undoubtedly that of the glauconitic sandstone immediately underlying the Cobden limestone at Port Elizabeth.

The large oysters which were found before in the sandstone overlying the coal in the Nine Mile Bluff have now been discovered in a micaceous sandstone which overlies the upper seam of the Buller Coal Field, in the Orikaka Valley, and which appears to be the same rock as that which overlies the upper seam in Sims's drive.

At the Amuri Bluff measured sections of the different beds have been made during the latter part of the present season, and if not exhaustive, at all events very extensive collections have been made from the different beds, the result being to add a great number of species to those previously known.

It further appears from this work that, as far as stratigraphical evidence can show, no unconformity exists between the *Leda* marls and Amuri limestone, nor between the Amuri limestone and beds of the Amuri Group, and this is strengthened by palæontological evidence, Pecten zittelli having been traced from the *Leda* marls down into the Amuri limestone, and Inoceramus having been traced from the Amuri Group proper up into the Amuri limestone. A list of the measurements of the various sections is herewith appended :—

—		Sec. AA.	Sec. BB.	Sec. CC.	Sec. DD.	Sec. EE.
		S. Bluff	Okarahi Creek	Bluff, N.E. face	Kais Hill	Coast Sect.
Chalk Group.	Leda beds ..	630 feet	360 feet			440 feet
	Amuri limestone ..	630 ,,	260 ,,	330 feet		430 ,,
Greensand Group.	Teredo limestone ..	80 ,,	30 ,,	81 ,,	30 feet	35 ,,
	Saurian beds	450 ,,	445 ,,	700-500 ,,	485 ,,	500 ,,
Amuri Group.	Black grits	20 ,,	20 ,,	25 ,,	20 ,,	20 ,,
	Grey sands	315 ,,	365 ,,	215 ,,	210 ,,	180 ,,
	Calcareous conglom.	180 ,,	200 ,,	240 ,,	200 ,,	160 ,,

The spirifer slates and madrepore limestones of Reefton have been further examined, and the result has been to show that these beds do most undoubtedly underlie unconformably the Maitai or auriferous slates, for these two formations must be considered to be identical.

The examination of the western flanks of the Southern Alps went to prove a somewhat greater development of the older crystalline rocks than was formerly supposed, but beyond that, from a purely geological point of view, nothing of importance was attained.

A list is appended showing what appears to be the relations of the various beds examined, liable, of course, to alterations which may arise when a thorough comparison of the fossils shall have been completed.

	NAPIER TO POHUI.	C. KIDNAPPERS TO C. TURNAGAIN.	RAGLAN & MERCER.	WANGAROA.	WEST COAST.
WANGANUI FORMATION	Loose brown sands Shell limestone Brown calc. marly sandstone				
	Conglomerates Blue sandy marls Pohui limestone	Conglomerates Sandy clays Coarse conglomerates Te Aute limestone			Conglomerates
KANIERI SERIES.	Glauconitic sandstone	Blue sandy marls Marly beds			Loose brown sandstone Shell limestone Blue marls Greensands
TAIPO BEDS		Brown quartzose Sandstone, with concretions Calcareous sandstone Nummulitic limestone	Kawhia limestone Aotea sandstone		
CRETACEO-TERTIARY.			Clay marls Papakura limestone Green-sands Waitemata beds Leda marls	Calcareous sandstone Green sandstone Shales	

In no case is the thickness of the *Leda* marls complete, and in the section of the Amuri limestone, Section AA., there is a possibility of a mistake having crept in, as the thickness is so much greater here than in the other sections. With these exceptions, the thickness may be taken as reliable within a comparatively few feet.

SPECIAL COAL EXPLORATIONS.

With reference to coal explorations, at the request of the Hon. Mr.

Chamberlain, the Raglan District has been examined, with a view of proving whether coal exists in the locality, and the only way to prove its existence or otherwise has been shown to be by boring; on the banks of the Waitetuna branch of the harbour, being the most likely place to put a bore-hole down.

At Jackson's Bay the coal measures occur, but all lying at comparatively high angles. Notwithstanding this, they have gone to considerable expense in sinking shafts and putting in drives in the marls, having been led on to this expense by finding small pockets of carbonaceous material in them. When the locality was visited in January, 1876, it was proposed to sink a fresh shaft through the marls for a depth of 150 feet· This, of course, would have been money thrown away, as any coal which may be found in the district would be seen to crop out at the surface, and explorations carried on with a view of tracing any such outcrop which may occur would be more likely to be attended with success than any borings whatsoever.

At Wangaroa north a shaft and several bore-holes have been put down, some of them to a considerable depth, with no good results.

In all cases these works have been carried on in the black shales of the secondary rocks, and in no case have they reached the underlying strata. The beds here also are lying at angles of from 35° to 70°, and the workmen report cutting a seam three or four inches thick in a bore-hole near the beach, but Mr. McKay states that he was unable to discover anything so thick even as that at the surface.

From Wangarei we have had samples of coal for analysis, which compared very favourably with the other North Island coals, but no one from the Department has visited the locality since the discovery was made.

At the Abbey Rocks, and near the Paringa Lake, a development of the coal measures occurs, and thin seams, about eight inches thick, have been found; but, up to the present time, no seams of a workable thickness have been seen. The lithographic stone of this locality, which is at present being opened up, by bringing more people to the district, will tend to further prospecting for coal.

A fair extent of the coal measures has been shown by Mr. Cox, who has visited the locality.

A company is being formed at Greymouth to work the Nine Mile coal, and Mr. Young has surveyed a line between there and Greymouth, which I understand it is proposed to construct by private contract. They are talking of taking up an immense area of 4,000 acres, which would be far too large for any one company to work to advantage. A coal mine at Coal Creek, Greymouth, is also proposed to be opened.

In the Buller Coal Field the survey is about completed between Westport and the Ngakawau, resulting in, roughly speaking, over 100,000,000 tons of available coal being mapped. The survey is to be completed by December.

The lithographic stone of the Abbey Rocks has been very highly reported on by various people in Melbourne and elsewhere as regards its quality, but practical lithographers are still somewhat doubtful as regards its value for crayon work. It occurs in very considerable quantities, and could be procured in slabs of almost any size, so the success of the quarry simply resolves itself into the question of demand. Some slabs of this stone were forwarded to the Philadelphia Exhibition, but through Victoria, so that no mention of them occurs under the New Zealand exhibits.

SILVER MINES.

Two mines have been started for silver, one at Richmond Hill, Collingwood, promising to be a genuine success if worked in a proper manner. At the present time they have got their lode 14 inches wide, and two droppers, each of four inches in width, are coming down to join it. The lowest assay of this ore has given 78 ounces of silver per ton, while the highest returns as much as 596 ounces.

The other mine, at Mount Rangitoto, near Ross, is in a pyritous lode, about 10 inches thick, with not more than 20% galena in it, which carries the silver.

Very varied results have been obtained by the assays of this ore, ranging from 10 ozs. 17 dwts. of silver per ton, as assayed by Mr. Skey, to 735 ozs. per ton, as assayed at the Melbourne University.

This is partially explained by the fact that the Melbourne results are given confessedly on the Galena, *not* the ore, which would reduce the yield to 147 ozs. per ton of ore; but even that we have never been able nearly to reach at the Colonial Laboratory.

Before I left the Colony antimony ore (Stibnite) had been discovered in Endeavour Inlet, Queen Charlotte's Sound, the lode at the surface yielding from 30% to 60% of metal. The facilities for shipping from the locality are very good, and when the mine is opened there seems every probability of a good supply of ore. Nothing has, however, up to the present time been done to prove this below the surface.

JAMES HECTOR,
Director.

GEOLOGICAL REPORTS.

REPORT ON COAL AT WAIRARAPA.

BY S. HERBERT COX, F.C.S., F.G.S.,
Assistant Geologist.

28th December, 1874.

IN reference to the coal field said to have been discovered in the Wairarapa district, according to instructions I called upon Mr. Wardell on Wednesday last, and went with him and the discoverers to inspect the same.

A seam of coal, about 2 inches thick, occurs cropping out on both sides of a water-course, which runs from a raised terrace down to the Wairarapa Plains, the main range of the Rimutaka lying away to the back. The seam dipped under this terrace through a stratum of thick blue clay at about 30° N.N.W., and for the short distance that it could be followed while I was there showed no signs of improvement.

From general appearances I should judge that it was only a tertiary brown coal, and not worth following; but, as the discoverers claim £500 reward for their discovery, I informed them that they must prove the existence of coal in workable quantities before they could substantiate their claim. They seemed sanguine, and determined to follow the seam, for a short distance at any rate.

The approximate analysis gave :—

Fixed Carbon	45·15
Hydro-Carbon	30·99
Water	17·09
Ash	6·77
	100

This is very similar to the sample given me when at Pakuratahi, and classed as 1662—Lab. Rep.

REPORT ON ANTIMONY MINE, ENDEAVOUR INLET, QUEEN CHARLOTTE SOUND.

BY S. HERBERT COX, F.C.S., F.G.S.,
Assistant Geologist.

30th January, 1875.

In accordance with instructions, I left Wellington on Saturday, 23rd January, by the Ladybird, arriving at Picton the same night. On Sunday I called upon Mr. W. Clark, and arranged with him to start for Endeavour Inlet on Monday morning to inspect the workings at the mine.

The reef, which was discovered in 1872,* and is at present being worked by a private company, was first struck at the north end of Endeavour Inlet; and from this point, as a centre, all prospecting and mining operations generally have been carried on. The main lode has been followed from the N.E. corner for about 140 chains in a N. 55 W. direction, where, at the summit of the dividing range between Endeavour Inlet and Port Gore, it assumes a somewhat more northerly direction. Following this lode in an opposite course, it may be traced, preserving the same line of strike, as far as Resolution Bay, a distance of about 4 miles. The accompanying sketches show the position which the lode takes, it being noticeable that it strikes in nearly the same direction as the Turner Gold Reef,† and may therefore be looked upon as a right lode, W.N.W. and E.S.E. appearing to be the strike of right lodes in this country.

Mining operations have been commenced at a point situate about 70 chains from Endeavour Inlet, along the line of lode, and a tramway is also being formed from this point, with a view of bringing the ore down to the water for shipment.

The main lode outcrops at this place in a creek, where a surface of from 10 feet to 15 feet appears, but this, being bared by a slide which occurs, and which crosses the lode at an angle, is not reliable data for its thickness. Following the line of strike from this point up the hill, various minor workings have been carried forward, to prove the existence of the lode; but not until we reach the miners' camp, which is about 90 chains from the beach, have any explorations been made which are valuable as giving definite information as to the thickness of the lode.

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* Hector. Geol. Rep., 1872, p. 129.

† l.c., p. 126.

At this point a drive has been put in, and at a distance of a few feet the lode has been struck, not, as might have been expected, in a regular quartz gangue, but the antimony ore forming the lode, the quartzose part being only disseminated through the ore. The lode here is about 4 feet thick, the quality, however, varying a good deal in the thickness, the richer part lying at the top of the lode, and maintaining its apparent quality for a depth of about 2 feet, the lower portion being very inferior. Analyses which have been made at the Colonial Museum give the following results:—

Upper part of lode	44·28 per cent. Sb.
Lower part of lode	17·20 per cent. Sb.

At a short distance below the drive a shaft has been sunk, striking the lode at a depth of 25 feet, the thickness at this point being 3 feet, and the upper portion here, as in the drive, being the richer.

As stated, this lode strikes N. 55 W., S. 55 E., and it underlies at about 50° N.N.E. The thickness has not been proved at other places than those mentioned; but, its continuity being established, further knowledge as to its thickness would be comparatively valueless, as lodes are pinched and widen out in so throroughly an erratic manner as to render any calculation as to their cubic contents but most hypothetical. Added to this, the fact that the average of samples which have been sent heretofore to the Museum for analysis, give an average percentage of 50 to 60 antimony; the following being a list of the samples:—

Date.	Forwarded by	Percentage.
June, 1874	H. Curtis, Esq.	58·25
" "	" "	51·12
March, 1874	" "	69·04
" "	" "	36·36

and that the present samples give much inferior results, though brought from within short distances from the previous ones, only proves, what is a well-established fact, that in metalliferous mines the quality as well as the quantity of the mineral is apt to vary to an indefinite extent in a short distance. A specimen forwarded by T. H. Fielding, Esq., July, 1874, was assayed for gold and returned 3dwt. per ton. This lode which consists of antemonite ($Sb^2 S^3$), sp. gr. 4·5 to 4·6—the only ore of antimony which has as yet been discovered in sufficient quantities to pay for extraction—is coated to a large extent with antimony ochre ($Sb_2 O_3, H_2 O$) and kermesite ($Sb_2 O^3, 2 Sb^2 S^3$), which are due to the partial decomposition of the antimonite, and it also, as has been before stated, contains traces of gold; about 2 dwt. per ton being the largest return at present. The fact, however, that the ore contains gold, even in small quantities, is encouraging, as in gold-bearing countries antimonite frequently contains gold in large enough quantities to pay for extraction. The rocks of this neighbourhood are very similar in character to those of the Thames and Otago goldfields, and gold is being worked at the Turner Mine, which is only a short distance off; so that all samples sent away for sale should be assayed for gold. The country through which the lode runs consists of a finely-grained greenish schistose rock, changing to a greyer colour, and becoming somewhat quartzose in the higher portions. In the immediate vicinity of the lode it assumes a pinkish brown colour, due probably to the presence of iron, although the lode itself may have had something to do with the alteration, it being noticeable, on following the creek up to the head, that these brown rocks disappear entirely, the line of demarcation being very decided.

The lode underlies at 50° N.N.E., and the general dip of the strata is in the same direction, but at the less angle of 23°. The hanging and foot walls of the lode are both of the same character, but at places a decomposing rock appears, as a capel, of a grey colour, and probably containing a small proportion of antimony.

As before mentioned, a slide has occurred crossing this lode, and it appears to have taken place down a seam of good blue clay which occurs here. The whole of the country past this slide is composed of a loose gravelly material, with blocks of antimony appearing throughout it, many of them being of very considerable size.

Parallel to the above-mentioned lode, and at a distance of from 9 to 10 chains from it, another small lode appears, underlying at an angle of 50° N.N.E., as in the case of the larger one. This lode consists of a decided quartzose gangue, antimony only appearing in small pieces throughout it. The greatest thickness of this lode is 1 foot; and it has been found both at the place where the workings are being carried on and also at Resolution Bay; no trace of it, however, has as yet been found on the dividing range, nor at Port Gore. To all appearance, this lode is of but small importance; but it is worthy of note that it is a right lode—that is, it is running in the same direction as the general ore-bearing lodes of the district, and may, therefore, be expected to improve.

A third lode also occurs here, running at right angles to the other two; the only place where it has been found being at a point between them. It dips W.N.W., at an angle of 30°.

It becomes a great point of interest to note where these lodes meet, as at that point a considerable improvement may be looked for in the mineral being worked. The last analysis of this ore, performed at the Colonial Museum, gives only 19·10 per cent. Sb, but previous specimens having returned a far higher percentage, it may again improve.

Judging from the quality of the ore, I should certainly say that some operations are necessary in the way of dressing before it is sent away from the mine. The richer portions might be picked and shipped without further treatment, but those (and they seem to be the larger proportion) in which a large percentage of extraneous matter occurs mixed with the ore require some further treatment. The sp. gr. of antimonite is 4·5 to 4·6; that of quartz, which is the principal impurity, is 2·6, and, I believe, these might be separated by means of the difference in their specific gravities, by stamping, and either running through drags with but a small incline, or, better still, by carrying the stamped stuff to a Borlase's separator, or some modification thereof. The value of antimony ore decreases at a greater rate than the percentage of antimony in it does, in addition to which, by the ordinary method of heating in a reverbatory furnace, and running the sulphide from the bottom, at least 10 per cent., and frequently as much as 25 per cent. is lost; and it would seem advisable to separate this sulphide, as far as possible, in the first instance by mechanical means, and afterwards to reduce it direct, using iron as a reducing agent.

In conclusion, I may say that since the time, some 25 years ago, when Rajah Brooke discovered large quantities of antimonite in Borneo, and, bringing home two shiploads of the ore, completely stocked the market, no such find, as regards quantity, has been known—always supposing that the lode does not thin out at a short distance down, and appearances give no reason for supposing this to be the case.

Every facility for shipping exists, such as deep water, good anchorage, etc. The land is well covered with timber suitable for mining purposes, and the distance which the ore has to be conveyed to the shore is not more than 90 chains, this being moderately easy ground for tramming, and offering every facility for putting up a self-acting tram to bring the ore down the hill. Plenty of water-power is also at hand, so, should dressing be resorted to, they have the best opportunities to carry it out as cheaply as possibly.

Antimony is on a rising market, the supply being always less than the demand; nor is there much fear of the metal being overstocked, as the new applications which it receives every day render it constantly more and more important in commerce, and more and more in demand.

It at present enters into the composition of type metal, music metal, plate pewter, Britannia metal, Queen's metal, antifriction metal. It is used for purifying gold, and I understand has lately been employed, in conjunction with manganese, for hardening iron, being used extensively in the manufacture of Armstrong guns, armour plates, etc., but I am unable to give any definite information on this point.

The part which antimony plays in its alloys is that of rendering them harder and less ductile, and the highest proportion which can be introduced without rendering the alloy brittle gives the best result.

ANTIMONY ORES (STIBNITE).

a Contains 19·01 per cent. of antimony.

b Contains 44·28 per cent. of antimony.

c Contains 17-20 per cent. of antimony.

NOTE.—The quartz in samples *a* and *c* is somewhat high, being about 73 to 75 per cent.; and in *b* it only amounts to a little more than 37 per cent.

REPORT ON NELSON DISTRICT.

BY S. HERBERT COX, F.C.S., F.G.S.

1st March, 1875.

I HAVE the honour, in pursuance of instructions, to make the following report on the Nelson district, from the Dun Mountain to D'Urville Island, as regards its probable mineralogical value:—

The greater part of this area is covered by the Maitai series, consisting of green and purple slates, flags, rotten banded slates (highly cleaved), and then calcareous slates traversed by veins of calcspar, and passing eventually into a regular bed of limestone. Beyond this the slates again come in, being still calcareous in character, and they continue until reaching the serpentine, which may be traced from the Dun Mountain to the Croixelles, appearing again on D'Urville Island, and which forms the boundary line of my present survey.

The general strike of all the above-mentioned rocks is about N.E., and they may be traced throughout, from the Dun Mountain to D'Urville Island, so that any remarks which I may make on these will apply equally to the whole of that area.*

In the immediate vicinity of Nelson the slates, etc., occur in a considerably altered condition, and interstratified with beds of an amygdaloidal character. At Pepin's Island, and also on the mainland, syenite occurs, it being possibly to this that the Nelson Boulder Bank owes its origin.

Having thus briefly described the geological structure of the country, I will proceed to the object of this report.

In the serpentine, copper has been discovered at a few places, that at the Dun Mountain and on D'Urville Island being the best. This copper only occurs in pockets, and any mining operations carried on in the pursuit of it would necessarily be of the most uncertain character, and the search after the mineral would have to be conducted purely by chance.

I need not mention the disappointment and loss which have ensued from an attempt to work the copper at the Dun Mountain. It was to have been expected, as sufficient explorations were not made in the first instance; but, at the same time, I would point out that it is not at all satisfactorily settled that copper does not exist in large quantities here.

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* See Davis. Geol. Rep., 1870, p. 103.

That it does exist is certain, as a certain quantity has been obtained from several points, but, so far, it has not been found occurring over a sufficient area to pay.

Irregular deposits of copper are not infrequently found in serpentine, although it has not often been the case that it is found in large quantities, but one remarkable instance may be mentioned, viz., that of the "Monte Catini Mine," in Tuscany.

The rock here was a steatitic serpentine, with finely disseminated iron pyrites running through it, and at the junction of this with the adjoining rock an irregular deposit of copper ore occurred, as a rule quite free from impurities. Copper, glance, bournonite, and copper pyrites were the principal ores, and from 1837 to 1867 about 40,000 tons of ore were extracted, yeilding an average of 35 per cent. of copper; the yield of the English mines being generally about 6 per cent.

I give this instance to show that it is not at all impossible, nor indeed improbable, that copper does exist in this locality, but, if it does, it is only as irregular deposits, and will only be discovered by accident.

Chromite always occurs in connection with serpentine, and the present case is no exception to the general rule; but, as there are considerable quantities of mineral much nearer home, and the supply considerably exceeds the demand, it must be looked upon as of but little value.

With reference to the question as to whether lodes may be looked for in any of the rocks other than the serpentine, I may remark that the slates of the Maitai series are much broken and traversed by veins of quartz, their general strike being northerly, but veins also appear striking E. and W.

These quartz veins extend into the limestone, which, where it appears at the Croixelles, has become deep green in colour, and is traversed, in addition to the quartz, by strings of iron pyrites.

Copper frequently occurs in clay slate, more especially when traversed by mineral springs and serpentinous rocks, and I cannot but confess my conviction that it will be found here, the most likely place to look for it being in those slates between the serpentine and the band of limestones, the limestone itself not being overlooked.

REPORT ON RAGLAN AND WAIKATO DISTRICTS.

BY S. HERBERT COX, F.C.S., F.G.S.

To accompany Maps and Sections.

4th March, 1875.

Instructions to Mr. Cox by Hon. W. B. D. Mantell.

You will proceed at the earliest opportunity, accompanied by Mr. McKay as field-assistant and collector, to Raglan, Aotea, and, if possible, Kawhia, in order to determine the relations of the coal-bearing beds to the Jurassic strata there, and especially to investigate the source of some specimens of bituminous coal and ironstone which have been forwarded here from that district.

With reference to these matters, you will consult Captain Hutton's report and map, published in the Reports of Geological Explorations;* and Hochstetter's map of Aotea and Kawhia.†

This work being done, you will extend your actions to the Waikato Basin at the Kupakupa Mine, and towards the Miranda Redoubt, from which place a report has been called for.

Mr. McKay should, as well as yourself, keep full journals of the work done, from which you will draw up your final report.

The collections made should be forwarded from time to time as opportunity offers.

You will take care to keep me constantly aware of your movements, and to forward short reports of the progress you have made with the work.

Wellington, 11th June, 1875.

I HAVE the honour, in pursuance of your instructions dated 4th March, to make the following report on the Waikato district, from Aotea to the Miranda Redoubt, not having been able to pursue my investigations as far as Kawhia.

It will be seen, on reference to the accompanying map and sections, that a long back-bone range of hills, averaging about 700 feet in height, exists, running from a little to the eastward of Aotea Harbour to Pukorokoro, on the Frith of Thames, through a gorge in which, at Taupiri, the Waikato takes its way.

This range is composed chiefly of slates of a highly pyritous character, the pyrites being finely disseminated throughout the rock, and accounting for the large amount of decomposition which is going on in it at places.

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* Geol. Rep., 1867.

† Hochstetter. Geol. of Novara Expedition.

In these rocks, but only at one point, we found large numbers of *Monotis salinaria*, on the occurrence of which, in the Richmond beds, Dr. Hochstetter ascribes to them Triassic age. This, added to the great similarity between these beds and those at Richmond, in mineral character, justifies me in placing them in the same horizon as the Richmond beds, and I shall accordingly speak of them throughout this report as the "Triassic slates," and being the Wairoa Series of Dr. Hector's Map of New Zealand.

These Triassic slates form the boundary of the Waikato Coal Field to the eastward, all the rocks lying to the north and west of them following a direct sequence from the lowest beds, or coal measures, to the Kawhia limestone, these being overlaid unconformably by the Pleistocene formation.

The probability is that coal exists over the whole of this area, although over the greater part of it the depth would be too great to allow of advantageous working for the present.

The boundaries of the various strata, as near as can be determined by a rough survey and with maps to so small a scale, are marked on the accompanying map, the sequence being as follows:—

Pleistocene	Blown sands.	
	Boulder formation.	
	Pumice terraces.	
	Plastic clays.	*Chione stuchburyi.* *Cerithium rugatum.*
Tertiary ...	Kawhia limestone ...	*Waldheimia lenticularis.* *Panopæa plicata.* *Pecten hutchinsoni.* *Schizaster rotundatus.* *Perna* (Napier formation). *Pectens* (several). *Cardium.* *Macrodon.* *Turbo.* *Mytilus.*
	Aotea sandstone ...	*Cucullæa alta.* *Pecten hochstetteri.* *Turritella gigantea.* *Struthołaria senex.* *Struthołaria tuberculata.* *Dentalium tenuis.* *Panopæa.* *Volutes.*

Tertiary ...	Aotea sandstone ...	*Fusus.* *Echinoderms.* Oysters. *Turbo.* *Turbinolia.* *Lutraria.* *Venus.* *Cardium.*
	Clay marls	*Solinella australis.* *Panopæa plicata.* *Turbinolia.* *Pectens.* *Strutholaria.*
Cretaceo-tertiary...	Papakura limestone...	*Pecten hochstetteri.* *Echinoderms.* Net corals. Branching corals.
	Green sands ... Brown sands (Foote's) Brown sands (Mercer)	*Pecten zittelli.*
	Waitemata beds ...	*Dentalium nanum.* *Nautilus.* *Schizaster.* *Cardium.* *Leda.* *Crystallaria haastii.* Coiled *Nummulites.*
	Leda marls	*Dentalium tenuis.* *Pecten zittelli.* *Strutholaria senex.* *Solinella australis.* *Turbinolia.* *Crystallaria haastii.*
	Coal measures ...	No fossils.
Trias ...	Slates	*Monotis salinaria.*

The Coal Measures.—These appear, flanking the Triassic range, on the eastern side, at Whata-Whata, and stretching for some distance towards Ngaruawahia, before reaching which, however, they entirely disappear.

At Kupakupa they make their appearance on the other side of the Triassic range, where a coal mine is being worked under great natural advantages, being level, free, and having the Waikato running close by the mine.

The seam at this point averages about 18 feet in thickness, and the supply may be looked upon as almost unlimited if the workings are properly attended to.

The mine is worked on the pillar system; but the pillars which are being left appear too small for advantageous working in the long run. This is, however, I believe to be remedied in the future workings.

A thickness of about 45 feet of fire clay, varying in quality, exists between the seam of coal and the Triassic slates at this point: the coal being overlaid by a sandstone roof, with dicotyledonous leaves, and then by fire clay, passing into a yellow clay with nodules of clay ironstone.

This is by far the largest area of coal in the district, but on the other side of the Waikato two or three outlying patches of the coal measures appear dipping to the N.W. from the Triassic range.

These assume, in the neighbourhood of Mr. Foote's, and also on Mr. Graham's property, an area which would justify their working, supposing communication can be effected either to the Waikato or, better still, to the Frith of Thames, at Pukorokoro, as proposed by the company which it has been attempted to form to work this area.

They would by this means be freed from the opposition they would necessarily experience on the Waikato from the Kupakupa mine, which would doubtless have the advantage of them in facilities for shipping, etc.

The analysis of the ironstone on this property, performed by this Department, and returning 62·30 per cent. of metallic iron, is undoubtedly that of a picked specimen from an area where heat, but whence derived I am at a loss to determine, has dehydrated the fire clays, and, to all appearances, partially smelted the iron.

The true band of ironstone, which is about 3 feet thick, belongs to the order of clay ironstone (carbonate of iron). It returns 39·56 per cent. metallic iron, and is of a good useful character.

Leda Marls.—These beds occur at Foote's, overlying the the fire clays of the coal measures, the fire clays themselves attaining here but a comparatively small thickness. They are greasy in character, and, save that they contain fossils, are not at all dissimilar from the fire clays themselves.

They also appear on the western banks of the Waitetuna, and at various other points in the Whangaroa Harbour, where they are the lowest strata visible, the underlying coal formation not appearing anywhere in this district, although it would probably be struck at no great depth on Captain Johnson's property.

Certain altenations of marls and loose brown sands occur at Mercer, and, both here and on the other side of the Waikato, cover a considerable area; they pass in their higher beds into loose brown sands, to be hereafter mentioned, and, in their lower, into marls decidedly greasy in character, and in all probability of the same horizon as the *Leda* marls, although the fossils do not absolutely fix them as such.

They are described by Dr. Hochstetter as the Waitemata beds, and he places them below the Papakura limestone, which would entirely correspond with my observation with regard to the *Leda* marls, and I accordingly describe them in connection with those beds.

Greensands.—These appear in the Whangaroa Harbour, overlying the marls, and not attaining at this point a greater thickness than about 10 feet. No fossils occur in these beds at this point. Overlying the marls, at Mr. Foote's, loose brown sands appear, which probably have their counterparts in the brown sandstone which occurs underlying the greensands in Whangaroa Harbour. They attain, at this point, a thickness of at least 150 feet, and *Pecten zittelli* was found in them.

The brown sands at the top of the Waitemata series are doubtless the equivalents of these, but we were unable to discover fossils in them at Mercer, where they occur in considerable force.

Papakura Limestone.—This limestone, which forms high cliffs at Papakura, is next in the order of sequence.

It appears on the north side of the Whangaroa Harbour, near the entrance, and continues for a short distance up the Harbour.

It again makes its appearance on the Waitetuna, in Bridle Creek, and at one or two places in Turerua Creek, and in each of these places is underlaid by the *Leda* marls.

It again appears at Taranaki Point, and in one or two other places in the neighbourhood of Aotea Harbour, passing in its lower beds into a calcareous sandstone, and then marls, which I did not get an opportunity of seeing well, the Maoris being jealous of one going about there.

It makes its appearance once more on the eastern side of the Hakarimata range, near Whata Whata, where it is underlaid by sandy beds, probably corresponding to the brown sands of the Waitemata series, the coal measures themselves appearing below.

Clay Marls.—These beds, called by Captain Hutton the "Whangaroa clays," make their appearance in the Whangaroa Harbour, overlying the Papakura limestones, and form a considerable feature in the country at that place. They also occur north of Te Kahe Point, and extend from there to Te Kara Point, where the sequence from them up to the highest beds in the series, the " Kawhia limestones," may be well seen. They also cover a considerable area of country, extending across to the Wangape Lake.

Aotea Sandstone.—This sandstone, which covers a large area to the south-east side of Aotea Harbour, makes its appearance again to the north of the Whangaroa, and also in isolated patches in between. It covers a considerable area, a short distance to the north of the Whangaroa Harbour, coming down to the beach between the Whangaroa and Waitetuna Rivers, and again at Te Kara Point. It is highly fossiliferous in character, as may be seen by reference to the list of fossils at the commencement of this report.

Kawhia Limestone.—This limestone, which is much coarser-grained than the Papakura, appears overlying the Aotea sandstone at Te Kara Point, and from there strikes inland, not making its appearance again in the area over which I have been. I, however, show it in the position which it occupies on my map, from Captain Hutton's previous survey of this part of the country. It occurs in a large mass at Kawhia, and I shall have to make further mention of this at the end of this report.

The sequence of the beds to this point occurs without any unconformity, but from this point a break exists, and we next come to the

PLEISTOCENE FORMATION.

Plastic Clays.—These beds occur in isolated patches over the lower portions of the Waikato Basin, and their boundaries will be seen on the map. They lie in a more or less horizontal position, and contain beds of impure lignite and recent shells, but possess no particular interest beyond the simple definition of their boundaries.

Pumice Sands.—Extensive deposits of pumice sand occur, surrounding the course of the Waikato and Waipa Rivers, and forming innumerable terraces. In places they are consolidated, and form high scarps, considerably resembling limestone in appearance, and may readily be mistaken for such from a distance. They pass through two or three stages of coarseness. The finer sands are the lowest, these being overlaid by coarser sands, with angular fragments and pieces of pumice, and these again by the finer beds of river shingles, which are of course only local, appearing at the top. They, no doubt, owe their origin to river action, the material having been brought down by the Waikato from the Taupo district.

Boulder Formation.—This formation, consisting of doleritic lavas and tufas, covers an enormous area in the Waikato district, obscuring over the greater part of the country all other beds, and rendering the correlation of them a somewhat difficult matter in many cases.

Karehoe, Pirongia, and others of minor importance, were the centres of volcanic eruption at the time when the whole of the country was buried in the present manner.

Blown Sands.—These occur largely at the entrances of all the harbours on the West Coast, and are certainly of very recent date, the Rev. Schnackenberg assuring me that when he first landed at Raglan, 25 years ago, there was hardly a sign of blown sand where now large sand hills exist; and at Aotea they have evidently increased considerably in size since Dr. Hochstetter surveyed the country in 1859. These blown sands are very slightly magnetic, but there are extensive deposits of magnetic sand all along the coast.

With reference to the prospects of Raglan as regards coal and iron, on which I am specially instructed to report. The coal which was found at the foot of the Hakarimata Range, and on the discovery of which a claim has been made for £100 reward, appears to be a slip from the coal measures occurring on the eastern side of and capping the range; but, although this is the case, I have not much doubt but that boring in the neighbourhood of the Waitetuna, more especially on Captain Johnson's property, would result in the discovery of coal at no great depth, the strata which occur here being the same as those which overlie the coal at Mr. Foote's, and I should certainly recommend a bore-hole to be put down.

The iron sands, which occur in large quantities here, are of a similar quality to those at Taranaki, containing 7 or 8 per cent. of titanium, but not in sufficient quantities to interfere materially with the working of them, the only difficulty arising being that which has somewhat inconvenienced the works at Taranaki, viz., the necessity of forming the iron sand into bricks with their flux before smelting the same, which necessarily entails extra expense.

Brown hæmatite (limonite) also occurs at Raglan, on the slopes of Mount Karehoe, but, so far as I was able to see, only in blocks scattered over the surface; and, indeed, I can hardly account for their being there, save as a volcanic product, which would render it improbable that there should be any extensive depositions of the iron stone in mass.

Should coal be found by boring, as I have suggested, great facilities would certainly exist for smelting the iron sand, and any other iron ores which might be found in connection with the coal, as at Mr.

Foote's; but, unless coal be found, I hardly think any great steps are likely to be made at present in working the iron, as freight, etc., is so dear as to render it an expensive matter to ship coal to the port, and then re-ship the iron.

With reference to the Jurassic strata mentioned, none occur in the area over which we were permitted to go, so that I am unable to report on the connection between them and the coal measures, but doubtless no difficulty will arise in this matter when an entrance into Kawhia can be effected.

REPORT ON SURVEY OF BULLER COAL FIELD.

BY J. HERBERT COX, F.C.S., F.G.S.

To accompany Map and Sections.

13th May, 1875.

Instructions to Mr. Cox by Hon. W. B. D. Mantell.

PROCEED to Westport, inspect work being carried on by Denniston, on Mount Rochfort, in mapping coal areas, and fixing best sites for mines.

Incorporate Denniston's results in general report.

Wellington, 1st July, 1875.

I HAVE the honour, in pursuance of your instructions, to make the following report:—

I have, in company with Mr. Denniston, been over the area which he had surveyed up to the end of May, extending from the River Ngakawau on the north, to Coalbrook Dale, bounded by the Cascade Break, on the south; the Mount William Range and the sea face forming the boundaries on the east and west respectively.*

From Mr. Denniston's maps, showing the coal outcrops and probable areas over which coal exists, supplemented by my own observations, I have been enabled to draw out a geological map, with sections of the coal field.

The sequence of the strata is as follows:—

Black marls ...	*Pecten zittelli.* *Pecten fischeri.* *Echinoderms*, *Scalaria*, etc.
Upper grits ...	Fine in character.
Coal	Two seams of coal occur, the sections in connection with which cannot well be shown on the map, but various detailed sections at different points will be given in this report.
Lower grits	Coarse.
Triassic slates ...	Lying at all angles, and forming the base of the coal field.

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* **For general description of this Coal Field, see *Hector*, Geol. Rep., 1872, p. 135.**

Granite	Not appearing at the surface except in the sea face, in Crane's Cliff, at the Ngakawau, and in the bed of Granity Creek.

Parts of two basins exist in this area, the dividing watershed of the Ngakawau and Cypress Creek, which is one of the main branches of the Waimangaroa, forming their point of junction. I shall speak of these as the "Waimangaroa Basin" and the "Ngakawau Basin," and make allusion to them separately.

A third basin commences from the outcrop of the slates in Coalbrook Dale, in which the Whareatea is the principal river, and which includes Mount Rochfort, and that country to the westward of it; but, as this is not yet surveyed thoroughly, I shall reserve any further mention of it for a future report.

The Waimangaroa Basin.—This includes Coalbrook Dale, Mount William, Mount Frederick, and the intermediate country, extending northward to the before-mentioned watershed, and bounded by dotted lines on the map.

Mount William and Mount Frederick are the highest points of this basin, and it trends away to Coalbrook Dale; its continuity being there arrested by the Cascade Break, a fall of over 1000 feet.

In the face of the Cascade Break the lower seam shows a thickness of 18 feet, the upper one being only 5 feet thick at this point. The following is a section of the strata here:—

	Ft.	In.
(1.) Fine grits	8	0
Fine sandstone, with coaly partings ...	4	0
Coal (upper seam)	5	0
Dark sandstone	20	0
Fine white sandstone	14	0
Coal	6	0
Shale	0	3
Coal	12	0
	69	3

Both these seams thin out on approaching the outcrops of slate to the westward, and the whole strata appear to be much contorted; the lower grits appearing at places lying at a high angle, and denoting the vicinity of the slate, which makes its appearance in many of the beds of the creeks.

The following section is taken from the vicinity of the Coalbrook Dale drive :—

	Ft.	In.
(2.) Fine red grits	20	0
Soft sandstone	5	0
Coal (upper)	0	6
Fine grits	10	0
Soft sandstone, with coaly partings ...	10	0
Coal	8	6
Shale	1	6
Coal	2	0
Dark grey sandstone	20	0
	77	6

To the north of this point the lower seam gradually thickens until nearly reaching the Waimangaroa Break, where, at No. 4, its thickness is 40 feet, and from there it thins out towards the Mount Frederick summit; the following sections serving to illustrate this :—

The upper seam holds a thickness varying from 5 feet downwards over the whole of the basin, but more frequently appears as about 1 foot thick than anything greater.

	Ft.	In.
(3.) Surface fine grits	4	0
Soft sandstone and fine grits ...	20	0
Fine sandstone, with coaly partings ...	8	0
Coal (lower seam)	17	0
	49	0

	Ft.	In.
(4.) Surface grits	35	0
Soft dark sandstone	12	0
Fine grits	11	0
Shale	1	0
Soft sandstone, with coaly partings ...	12	0
Coal (lower seam)	40	0
	101	0

and similar sections prevail along the southern bank of the Waimangaroa.

The sections from this point towards the summit of Mount Frederick are as follows :—

	Ft.	In.
(5.) Surface	1	0
Fine grits	10	0
Fine sandstone	8	0
Coal (lower seam)	25	0
Brown sandstone	6	0
	50	0

resting upon hard grits.

	Ft.	In.
(6.) Grits	4	0
Soft sandstone	3	0
Shale	4	0
Coal (lower seam)	8	0
	19	0

and at the summit of Mount Frederick, at the edge of the basin, the following section is seen :—

	Ft.	In.
(7.) Fine grits	12	0
Soft yellow sandstone	10	0
Shale	3	0
Coal (lower seam)	6	0
Shale	1	0
Hard grits	6	0
	38	0

resting upon slates, and dipping S.E. 10°. As will be seen, the coal thins out gradually to this point, but at the summit of Mount William, on the other hand, the thickness varies very considerably in a short distance, and only covers an insignificant area.

The following sections serve to illustrate the variations in thickness above-mentioned :—

	Ft.	In.
(8.) Surface—fine grits	30	0
Soft sandstone	12	0
Soft fine grit	30	0
Shale	4	0
Soft sandstone grit	30	0
Soft sandstone, with coaly partings	12	0
Coal	6	0
	124	0

	Ft.	In.
(9.) Fine white grits	10	0
Soft sandstone, with coaly partings	12	0
Coal	2	0
Shale	1	0
Coal	1	0
Soft dark sandstone, with coaly partings	8	0
Fine grits	12	0
Soft sandstone	4	0
Fine grits	14	0
Fine sandstone, with coaly partings	6	0
Coal	30	0
	100	0

	Ft.	In.
(10.) Fine grits	24	0
Soft sandstone	6	0
Shale, with band of coal	3	0
Black stone, with coaly partings	25	0
Fine grits	4	0
Soft sandstone, with shaly partings	6	0
Dark sandstone	4	0
Red grits	10	0
Shale	14	0
Coal	40	0
Soft grey stone	6	0
	142	0

As will be seen by the map, a considerable area in the Waimangaroa Basin shows the lower grits appearing at the surface, all the higher beds (the coal included) having been denuded, and even where coal does occur in patches, the denudation has been so great as to leave a comparatively slight covering. Thus we get the following section at one point:—

	Ft.	In.
(11.) Soft white sandstone	12	0
Shale	2	0
Coal	20	0
	34	0

At the foot of the Mount William Range both seams of coal occur, the higher one being overlaid by the fine grits, and then, quite conformably, by black marls, containing nodules of clay and ironstone running in layers parallel to the bedding.

The whole of these strata are lying at a high angle, and have evidently slipped from a higher level, giving one the impression that the whole of the coal-bearing strata at this point, and part of the slates, had been denuded in former times by the Waimangaroa; and that the coal beds at present appearing had slipped from the face of the Mount William Range, blocking up the valley thus formed.

The Ngakawau Basin.—The boundaries of this basin are also shown on the map by dotted lines, and starting from the most southern point, near Mount Frederick, we find the coal thickening as we go north, giving sections of 5 ft., 25 ft., 37 ft., 40 ft. at various points, until, at the centre of the basin, we get the coal as much as 53 ft. thick, the bottom not being proved even at that depth. From this point the coal thins in all directions, and the following sections may be seen:—

		Ft.	In.
(12.)	Soft red grits	6	0
	Sandstone	12	0
	Coal	5	0
	Shale	4	0
		27	0

		Ft.	In.
(13.)	Shale	6	0
	Coal	25	0
	Shale	6	0
		37	0

		Ft.	In.
(14.)	Fine grits	5	0
	Soft sandstone	5	0
	Shale	0	6
	Coal	1	0
	Shale	0	6
	Soft sandstone	25	0
	Shale	4	0
	Coal	37	0
	Shale	5	0
		83	0

	Ft.	In.
(15.) Coal	36	0
(16.) Coal	40	0
(17.) Coal	53	0

	Ft.	In.
(18.) Shale, with coal	3	0
Coal	0	6
Soft sandstone, with shale and coal ...	6	6
	10	0

	Ft.	In.
(19.) Coal	3	0
Shale	0	9
	3	9

	Ft.	In.
(20.) Coal	1	0
Shale	1	10
Coal	0	6
Shale	0	4
Coal	2	0
	5	8

	Ft.	In.
(21.) Coal	20	0
(22.) Coal	18	0

Two well-defined faults occur in this basin, as shown on the map, thus dividing it into three areas.

The Higher Levels—The coal-bearing portion of which commences about 30 chains to the north of Mount Frederick, contain a seam of coal varying in thickness from 5 ft. to 37 ft., which is of good sound quality throughout, but different in character from that in the Waimangaroa Basin; it covers a considerable area, but, at the same time, denudation has removed an enormous quantity of coal, as is evidenced by the appearance at the surface, over the whole of the lower part of this area, of the lower grits with occasional patches of broken coal lying upon them.

The Middle Levels—Which form the most important part of this basin, as regards the quantity of coal which they contain, have a seam of coal running through them varying in thickness from 30 ft. to 53 ft.

and upwards, of which the lower two-thirds is of good sound quality—the upper part of the seam being so much broken and crushed as to render it comparatively useless. An average thickness throughout this area of 30 ft. might, I think, be calculated upon with certainty, of available character.

The Lower Levels—Which extend from the face of the lower fault to the Ngakawau and Crane's Cliff, do not give many outcrops of coal. In Crane's Cliff a thickness of 20 ft. appears, which is considerably crushed, but still is sufficiently good in character to warrant working, if the extent be proved.

The other outcrops only give a thickness of coal varying from 1 ft. to 3 ft. Whether these belong to the same seam or not remains to be seen. I will make further mention of this in the course of this report.

Slip Coal.—At the base of Crane's Cliff coal also occurs, about 18 ft. thick, lying at an angle of 45°, and evidently a slip from that in Crane's Cliff. It is overlaid by fine grits, and then by the black marls; but no good section can be obtained at this point to prove whether conformably or otherwise.

This coal has been worked to a small extent, and then abandoned, by the Albion Mining Company.

I was at first inclined to believe that the main seam in the Ngakawau Basin was the same as the upper one in the Waimangaroa Basin, as it resembles it more in appearance than it does the lower one; but the occurrence of an upper seam 1 ft. thick, in section 14, in addition to the fact that in the lower levels of the Ngakawau we only get sections of coal varying from 1 ft. to 3 ft. in thickness, except at one point, lead me to believe that this main seam is identical with the lower seam of the Waimangaroa, and that the outcrops of thin coal, which are got at sections 18, 19, and 20, are identical with the upper seam. If this be the case—and it would appear to be borne out by the improbability that a seam of coal would thin out from 40 ft. to 3 ft. in a distance of about a quarter of a mile, while the dip remains the same—the lower seam would in all probability be continuous over the whole of this area.

The analyses also appear to offer evidence in favour of this theory, as they vary indefinitely among themselves, and those samples from one basin appear generally to have their counterpart, as far as chemical composition is concerned, in the other.

The following is a selection from the analyses which have been performed of the coal from this district in the Colonial Laboratory, by Mr. Skey, and I have simply divided them between the two basins to show the general qualities of each.

Waimangaroa Basin.

Evaporative Power.	Fixed Carbon.	Volatile.	Water.	Ash.	Remarks.
7·7	59·32	28·68	6·01	6·02	Non-caking.
9·0	69·00	29·78	·60	·62	Cakes strongly.
8·0	62·09	30·96	6·43	·52	Cakes slightly.
7·4	57·48	37·64	4·57	·31	Cakes slightly.
7·6	58·41	35·02	5·19	·48	Caking.
6·0	46·01	30·81	11·52	11·66	Non-caking.
8·7	66·86	29·07	2·04	2·03	Cakes strongly.

Ngakawau Basin.

Evaporative Power.	Fixed Carbon.	Volatile.	Water.	Ash.	Remarks.
8·5	65·28	26·64	6·51	1·57	Non-caking.
9·4	72·48	21·22	5·55	·75	Scarcely cakes.
8·2	63·29	32·43	3·90	·38	Caking.
9·1	70·56	28·67	·39	·38	Non-caking.
8·2	63·16	33·53	2·92	·39	Cakes strongly.
5·4	42·40	36·60	9·20	11·80	Caking.
8·1	62·13	33·34	3·94	·59	Non-caking.

This completes the description of the coal of this area; but I may add that in many cases the ash is red in colour, denoting the presence of iron, probably as pyrites, which would of course render the coal more or less sulphurous. This ingredient is, however, in such small quantities, as a rule, that it cannot be looked upon as prejudicial to the coal.

Where can this Coal be Worked to Advantage?—This is, of course, a matter of great importance, and many things have to be considered, of which the following may be looked upon as the most essential:—

(1.) What is the quantity and quality of coal?

(2.) What are the means of conveyance to lower levels?

(3.) What would be the comparative cost of procuring timber?

The following is a rough estimate of the quantity of coal in the field, it being, I believe, rather under than over estimated:—

	Tons.
Waimangaroa Basin	32,000,000
Ngakawau Basin, high level ...	36,000,000
„ middle level ...	56,000,000
„ low level ...	16,000,000
Total	140,000,000

The coal in the Waimangaroa Basin is of a very good quality, being a hard sound coal, which forms a very light firm coke, and could be worked with the smallest amount of waste possible. It is, however, very badly situated as regards the means of transit, and will, I am afraid, be the last part of the field to be worked, notwithstanding the quality of the coal.

In the Ngakawau Basin the coal on the high levels is of a good sound quality, but more fragile than that in Coalbrook Dale, although it certainly comes next in quality to that. This area possesses the greatest advantages of any for the transit of the coal, a good leading spur running at a distance of about 30 chains from the face of the coal, where the main drive would be put in, with an easy gradient to the immediate vicinity of the railway. A self-acting tramway, constructed in three stages, would thus conveniently work the whole of this area, containing 36,000,000 tons of coal, a small winding engine only being required to draw the trucks to the top of the tram.

In the middle levels, as before mentioned, the upper part of the coal is crushed, but a very moderate estimate of the quantity of good coal gives as much as 56,000,000 tons, which renders this at once the most important part of the coal field. It does not present any great difficulties in the mode of transit, although involving a considerable outlay, as a tramway of about 2 miles in length would have to be constructed from the Ngakawau to the face of the coal; but, as a gradient of 1 in 6 could be got for this along the line which I have shown on the map, it would be self-acting, and the first expense would be the greatest, and the quantity of coal would fully justify the expenditure.

In the lower levels the quantity of coal is not yet proved, and it would be advisable, before commencing to work this area, to put down a few bore-holes to prove the amount of coal. If these prove satisfactory, I think the best means of transit would be down Romes's Line, from the face of the coal to where Romes's Line crosses—the line I have pointed out for working the middle levels. But this is open to further consideration.

With regard to timber suitable for mining purposes, the greater part of this field is utterly devoid of any, with the exception of the low levels and a few patches of no great extent scattered over the field, so that timber would have to be brought to the place; and it becomes a matter of importance to work with as little and as light timber as can safely be employed.

This brings me to the question of how these thick seams are to be worked to the best advantage. I cannot do better than to cite a few methods that have been employed in similar cases.

The "Dudley 10-yard coal" has been worked on a system known as "square work," which consists in putting a main drive in through the lower coal, ventilating it by means of a small separate air head. From this the main workings are opened, in the form of squares, 50 yards to the side, shut off by a rib of coal 7 or 8 yards thick, an entrance being effected through a narrow bolt-hole. These squares are worked out in stalls 10 yards wide, leaving pillars 10 yards square, and the whole of the seam is thus worked out at one lift. When the roof begins to break the square is abandoned, and a dam put in the bolt-hole, thus isolating this deserted square from the main workings. Of course, ordinary timbering is useless to support so high a roof, and the work is doubtless the most dangerous that can be engaged in; added to which, an unnecessary amount of waste takes place from the crushing of the pillars, and the impossibility of working the coal longer than the roof will stand of itself.

This system has of late years been superseded by the method of working the coal in two lifts, on the long wall system, with a greatly increased yield of coal; but even this system is hardly satisfactory, as the death-rate from falls of the roof in this district still continues to be very high.

The most successful system yet adopted is that employed in the Department of the *Saône et Loire*, where, at Montcean, near Blanzy, the seam is no less than 78 ft. thick, which would render it the nearest approach which we can find to our own coal fields. It is entitled "Working by *remblais*." This system consists in taking out horizontal slices of coal about 7 ft. thick, commencing at the bottom of the seam, and filling in the space with stone and earth from the surface. A band of coal of the same thickness as that taken out is left above this, and then another slice taken out, and filled in in a similar manner. After a few months this filling is found to solidify sufficiently to form a roof for the working of the intermediate coal which has been left. The plan of working may, of course, be on the "post and stall" or "long wall" system, as most convenient.

As the returns to the Government will, of course, depend upon the quantity of coal exported, I would respectfully suggest that, before granting mining leases to any companies, a stringent set of rules be drawn up, defining, within certain limits, the system of working to be employed; as by no other means can the maximum yield of coal be relied upon, and a guarantee be obtained that the mines will not be so mismanaged as to waste a large proportion of the coal, or even render it necessary to close the mine long before such a proceeding ought to be required; and, at the same time, if the workings are not carried on in a systematic manner, and with every precaution, life would be endangered to an unnecessary extent. To see these rules carried out, if formed, would necessitate the presence of a Resident Inspector of Mines on the West Coast; but when it is considered that, by charging a royalty of 6d. per ton on the coal, a sum of £3,500,000 would accrue to the Government, the expense thus incurred would, I think, be justified.

With regard to the further prosecution of the survey, Mr. Denniston is at present engaged on the western slopes of the coal field, where there is some quantity of slip coal being worked by Messrs. Roche and Co., the extent of which yet remains to be proved. It is lying at a high angle, and, I am inclined to think, will not be found over any very great area; but this will be settled in the course of a month or two.

In Cascade Creek some very good coal also occurs, similar to that in Coalbrook Dale; it is, however, evidently a slip from that coal, and a rough survey of this, to determine its approximate extent, will be the best guide as to whether it is necessary to expend much time over it or not. Further than this, I need make no remark, as Mr. Cooper has made suggestions in which I entirely concur.

A few quartz reefs appear running through the slates of this district, and containing gold, but, as far as can be seen, they are too thin for advantageous working; in fact, two have been tried and deserted.

A lode has recently been discovered in this neighbourhood by Mr. Liddle, which, from a rough inspection, appears to be principally an alloy of antimony and lead, sulphur occurring in it only in small quantities. It is reported to occur in the granite, and strikes N. and S., which appears to be the line of strike of true lodes in this district. As far as it has been traced, the lode is from 3½ to 11 inches in width, and is dipping to the east at the low angle of 20°. The discovery of this mineral is of great interest, and will no doubt give rise to a further examination of this part of the country for metalliferous lodes, which, from the juxtaposition of the granite and slate in the neighbourhood, may be looked for with a considerable prospect of success.

The black marls which overlie the top grits of the coal measures, as before mentioned, at one or two places are the same as those which appear above the brown coal of the North Island, and the sequence of the strata above them is much the same in both cases.

As conformity exists, from the black marls down to the bituminous coal in this district, the conclusion is that the geological age of the brown coals of the North Island is the same as that of the bituminous coals of the West Coast of the South Island; and, as in Wales, we get bituminous coal passing into anthracite, I see no reason to doubt that the brown coals here may pass into bituminous coals under favourable conditions, as they appear to have done in the Buller and Grey coal fields.

REPORT ON THE GEOLOGY OF RESOLUTION ISLAND, IN DUSKY SOUND, OTAGO.

BY S. HERBERT COX, F.C.S., F.G.S.

19th July, 1875.

I HAVE the honour, in pursuance of instructions, to make the following report on the geological formation of Resolution Island, Dusky Sound, compiled from notes obtained by me when visiting this locality to report upon the advisability of establishing a penal settlement there.

The main part of Resolution Island, viz., that to the eastward of the low land between Goose and Woodhen Coves, is composed of the older crystalline rocks; that to the westward consisting of older metamorphic slates and schists.

The strike of these is N. 10 E., and they dip at a high angle to the westward. The slates make their appearance again in Facile Harbour, where they are so much broken and traversed by veins of quartz as to render it quite impossible to make out their bedding at that point. They again appear on Anchor Island, where they are more schistose in character, and pass into gneiss to the eastward, which would form a good building stone. In Cascade Cove, on the mainland, the gneiss and garnetiferous mica schists prevail, and there is a moderate amount of flat country at this point, but which is evidently liable to heavy floods during the wet season, as *débris* appears in the trees as much as 16 feet above the present level of the river. A fine-grained dioritic sandstone also appears in the bed of the creek here, but I failed to discover this rock *in sitû.*

At the head of Dusky Sound, the rock, which still appears to be stratified, assumes a more granitic character, and would form an excellent building stone; but, from the formation of the country here, it was impossible to land, and it could not be utilised in any way for settlement.

The country on the eastern side of Duck Cove, Resolution Island, is comparatively low, and would, perhaps, offer an available site for gaol buildings. Up the creek, which discharges itself at this point, syenitic gneiss prevails, traversed by veins of quartzose porphyry, which is one mass of garnets, and in the gneiss itself the garnets frequently appear, a matrix of quartz always occurring round them, and evidencing the stratigraphical character of the beds, even if the bedding itself were not apparent.

Micaceous and hornblendic schists, with crystals of schorl, also appear at this point, the strike still continuing to be northerly, and the dip, at a high angle, to the westward.

At Occasional Cove, schistose rocks again appear, and there is no possible place for building, and the anchorage is bad.

I failed to discover any true granite on Resolution Island, but much of the stone which occurs there would form an excellent building stone, if other circumstances were considered favourable for the establishment of a penal settlement.

REPORT ON COAL AT SHAKESPEARE BAY, PICTON.

BY A. McKAY.

Instructions to Mr. McKay by Dr. Hector.

26th May, 1874.

I WISH you to proceed to Picton, in the next steamer, for the purpose of examining the coal seam referred to in the enclosed papers. In 1864 I discovered an outlier of marlstones containing *Dentalium*, *Pecten*, *Leda*, etc., just beyond the saddle, on the road to Blenheim, two miles from Picton. These marls appeared to me to overlie gritty sandstones and conglomerates that occur about a quarter mile further along the road, and which contain pebbles of the quartzites and schists of the surrounding mountains, the whole being highly inclined, and with a strike that would carry them in the direction of Shakespeare Bay, where the coal has been discovered; and, as I found obscure plant fragments in the sandstone, it is probable that the coal belongs to this formation.

In a report last year, Captain Hutton (Geol. Rep., 1873, p. 31) described these same beds as part of his Tuamarina formation, which elsewhere consists of mica-schist, pyllite, and other metamorphic rocks, and he refers the whole to the upper Palæozoic period. As the fossils I have seen do not bear out this view, and good sections have now been exposed in the Railway cuttings, you will be careful to make as full collections as you can obtain—not only of the fossils from the marly sandstone, but also of all the varieties of rock, and especially of the conglomerates—so as to be able to prove the nature of the included fragments.

The fossils mentioned by Captain Hutton are *Orthoceras*, *Phragmoceras*, and *Thracia;* but I can find no such Palæozoic forms in the collection he has deposited in the Museum.

I HAVE, as directed in the instructions appended, examined the strata (in which coal was lately found at Shakespeare Bay, Picton), and also made collections from the fossiliferous marls on the road to Blenheim, and the older rocks which occur in the district.

The older rocks I found occurring as below :—

1. Mica schists, confined to the district west of a line drawn from the saddle, on the Blenheim road, to the west side of Shakespeare Bay—with the exception of the hill terminating the peninsula between Shakespeare and Picton Bays, which is also mica schist.
2. Older slates, sandstones, and conglomerates, confined to the district east of the above lines.
3. Reposing indifferently on the mica schists and the less crystalline rocks, and occurring generally along the junction of the two, rocks belonging to the coal-bearing series of the West Coast are found. These rocks are chiefly developed on the east side and head of Shakespeare Bay, and extend through the neck of the peninsula, showing the best section on the west side of Picton Bay, where I observed the following sequence:—

1. Slates and sandstones, belonging to division 2, of the older series.
2. 30 feet of conglomerate.
3. 2 feet of fine-grained sandstone, blue when broken into, but weathering brown.
4. 120 feet of conglomerates, having a calcareous matrix, and abounding in the fossil remains of a large species of oyster and various forms of *Nummulites*, *Spines*, etc., which, in the higher part, become so abundant as to form a good limestone.
5. 700 feet of conglomerates similar in character to No. 2.

These rest against mica schists forming the hill terminating the peninsula.

Nos. 3 to 5 strike N. 30° W., with a dip to the N.E. 50°.

The other side of the peninsula, and the east side of Shakespeare Bay, gives a section showing a greater variety of rocks. Here we have—

1. Conglomerates of great thickness, occupying the head of the Bay and part of the east side.
2. Greensands alternating with the upper part of the conglomerates.
3. Marls containing nests of coal, sometimes traceable as thin irregular seams for a few yards.
4. Brown sandstones, with indistinct remains of shells.

The fossiliferous conglomerate appears to be quite local, and to be confined to the west side of Picton Bay.

At the saddle, on the road to Blenheim, the marly bed alone is present, and is here of considerable thickness, 150 feet at least. Coal only occurs under the conditions which exist on the east side of Shakespeare Bay. On the west side, rolled fragments appear amongst the shingle on the beach; but, as the bed rock here is mica schist, the specimens of coal must have been brought from the head of the Bay, where the rocks in which the coal occur are found. No trace of coal was to be found in the marls, at the saddle; but from these I collected a variety of fossils, *Dentalium*, *Leda*, etc., the whole resembling the fossils of the *Leda* marls in a marked degree.

I found the conglomerates further along the road to belong to the older series, and differing in character from the younger conglomerates, by containing much angular slatey matter and occasional boulders of quartzose porphyry.

Along the road from Picton to Blenheim, much-jointed brecciated sandstones appear, coarse-grained in character, and their joints filled with a white matrix; in character this rock strongly resembles that mentioned by Dr. Haast in his report on the Clent Hills. The strike and dip at this point are undetermined.

In the saddle recent accumulations occur, having a thickness of 25 feet, and resembling those of the saddle at the head of Te Aro Flat, Wellington Harbour. They are composed of reddish gravelly beds and clays, with thin beds of carbonaceous matter and some remains of trees, about 12 feet of rubbly conglomerate appearing at their base; the whole of these strata dipping 22° S.W.

These beds have given much trouble in the cutting (which has just been completed) through them, owing to their incoherent nature.

The north end of this cutting is through fossiliferous marlstones, striking S. 65° W., and dipping at a high angle; *Dentalium*, *Leda*, etc., have been found here in the roadside cuttings where the rock has been decomposed. Numberless plates of sea urchins appear, with many other fossils.

The rocks along Queen Charlotte Sound, in the direction of Shakespeare Bay, occur as follows:—Opposite the wharf the sandstone before mentioned appears striking N. 10° E., and dipping 85° E. Half a mile from the bay these cease, being succeeded by pebbly conglomerates composed exclusively of sandstone of the lower formation; they strike N. 30° W., and dip 50° N.E. These conglomerates gradually become more and more calcareous, changing eventually into a limestone, pebbles, however, always occurring throughout. These are succeeded by brown sandstone and fine-grained conglomerate.

As will be seen, these strata lie quite unconformably upon the sandstones below, and the position of the marlstones is probably below the lowest mentioned of these younger beds. In Shakespeare Bay the first rock seen is the conglomerate, then a very dark green sand, then marlstone in irregular masses, and then sandstone much resembling the underlying white-jointed sandstone; and here nests of coal appear, no seam, however, occurring.

South of Picton beds of fine-grained sandstone appear, striking N. 25° W., and dipping E. 45° to 62°, which are overlaid by the white jointed sandstone above alluded to. The lower part of this sandstone is very hard, and is used for road metal.

In the direction of the Maori Pah sandstones occur, and in a creek running down to the sea, at this point, conglomerates with quartzose fragments appear, as in the creek at Picton; but at the head of this creek the conglomerate itself appears, overlaid by green sandstones with quartz veins. These extend along the shore to the north-west headland of Boat Cove, where blue and light coloured slates, standing at a high angle and associated with green sandstones, appear. This conglomerate is essentially different from the younger one of the west side of the Sound, being composed of quartz pebbles with angular pieces of slate, whereas the younger one is composed exclusively of sandstone. From this, and their position, it would appear that these conglomerates are to be associated with the older sandstone series, not with the marlstone series, which, as mentioned, lie quite unconformably upon them.

After collecting a quantity of specimens from these rocks and the mica schist in the neighbourhood, and finding that there was little probability of coal being got in paying quantities, I returned to Wellington.

REPORT ON WEKA PASS AND BULLER DISTRICTS.

BY A. McKAY.

Instructions to Mr. McKay by Dr. Hector.

21st September, 1874.

I WISH you to make a rapid examination of certain districts in the South Island, with a view of collecting facts bearing on the subject of the relation which the upper calcareous beds and underlying reptilian beds on the East Coast bear to the calcareous beds and coal formation on the West Coast.

Proceed to the Weka Pass, by way of Christchurch, and collect from the calcareous green sandstone (the Weka Pass stone) and the underlying limestones exposed there, and connect them with the reptilian beds of Heathstock. Observe particularly the relation of the *Pecten zittelli* beds, which are exposed a few hundred yards up the creek from the hotel, as shown in Sketch Plan No. 1. Discover, if possible, the highest beds in which Saurian bones occur, and whether there is any distinct evidence from fossils, or otherwise, of a break in the formation between the limestone and the green sands.

Take coach to Culverden, and trace the fossiliferous limestones to Marble Point, on the Waiau, and note their relation to the limestones south of Rutherford's Bridge, on Montrose Station. (Sketch Plan No. 2.)

Search in the Upper Waipara for the Lower Amuri series, with a view of ascertaining if it is present underneath the Saurian beds.

Determine if the Saurian and overlying calcareous beds, and also the lower tertiary beds (Mount Brown series), can be followed continuously into the Upper Ashley, and thence to the outliers at Broken River (Trelissic) and the Rakaia (Redcliff), examining carefully, and making full collections from the sections exposed at the latter places. Sketch Plan No. 3 shows the Trelissic outlier.

Take coach from Castle Rock to the West Coast, and proceed up the Grey and to the Buller, by way of the Inangahua. Follow up the Buller to the Four-River Plain, and examine the fine section which occurs there—from the coal up to the calcareous beds. Thence across by the Owen River to Wangapeka, which will take you along the general strike of the coal formation.

Collect from the Triassic rocks in the Wairoa Valley, twelve miles from Nelson, as shown in Sketch Plan No. 6; and also examine the marls recently exposed in the railway cutting at Stoke.

6th January, 1875.

As directed in your instructions, dated 21st September, 1874, I have visited the various localities specified therein, and, as far as circumstances would admit, made the examinations required.

Firstly, with the object of discovering the highest strata in which the remains of Saurian reptiles might occur, I examined the series of rocks which have hitherto yielded these remains in the following well-known localities:—The Middle Waipara, including Bobbie's Creek and other tributaries in the same neighbourhood; the slopes of the Doctor's Hills, west of the Weka Pass; and the Upper Waipara, or Heathstock district. I found the same formation (Waipara beds) extending as large outliers up the valley of the southern branch of the Waipara, as far as Lee's Pass. They appear again at Redcliff, on the Rakaia, and form the lower beds of the Trelissic Basin at Castle Hill.

Referring to Dr. Haast's report on the Waipara district, (printed in the Reports of Geological Explorations, 1870–1), and adopting the principal subdivisions of the strata there proposed, but not noticing the minor subdivisions, it will be seen that four well marked divisions include the whole series to its supposed termination, viz., the Weka Pass calcareous green sands. These are as follows:—

1. Weka Pass series, including the Amuri limestone and overlying calcareous green sands.
2. Green sands.
3. Saurian beds.
4. Brown coal formation.

Saurian remains occur in the first division, and were found by me at Heathstock, when making a collection for the Canterbury Museum during May and June, 1872. They occur plentifully in the overlying concretionary beds (No. 3), but have not, up to this time, been found *in sitû* in the higher beds.

I was, however, fortunate enough to find portions of the skeleton of a very large *Plesiosaurus crassicostatus* in a detached mass of green sand (No. 2) near the junction of Birchhollow Creek with the Waipara, at the Limestone Gorge.

No trace of Saurian remains could be discovered in the higher parts of the green sands, nor in the marly beds that underlie the Amuri limestone, nor yet in the lower part of the Weka Pass series.

In the upper part of the Weka Pass series (calcareous green sands), bones are of frequent occurrence, but in so fragile a state, from decomposition, that their extraction is a matter of great difficulty. Many of the vertebræ, as seen in the rock, are decidedly bi-concave, but appear to have the neural spines anchylosed, so that, although they otherwise resemble the vertebræ of *Plesiosaurus*, this important difference leaves the matter uncertain, and it cannot be maintained for the present that Saurian remains are found higher than the green sands underlying the Amuri limestone.

I followed the Saurian beds along the slopes of the Doctor's Hills, both on the east and west sides, and examined outliers in Bird's Eye Creek and the southern branch of the Waipara, with a view of ascertaining if, in any of these localities, the Lower Amuri series was present. In all cases the formation, as in the Middle Waipara, commenced with the black oyster and *Conchithyra parasitica* beds, and were immediately succeeded by the Saurian beds with large concretionary boulders.

At Redcliff, on the Rakaia River, the Waipara beds are found at the base of a high cliff capped by tertiary limestone, the sequence of the lower part being, as in the Waipara,—

1. A thin bed of grey sandstone, followed by chalk marls, somewhat indurated.
2. Green sands, very dark in colour.
3. Quartzose sands, with occasional concretionary boulders, as in the Saurian beds.
4. Quartzose sands.

Overlying these are the equivalents of the upper Trelissic beds, which cannot be otherwise than unconformable, although this is not clearly shown in section.

In the Trelissic Basin, a similar section may be obtained on either bank of Broken River, below the Limestone Gorge, at its junction with the Thomas River.

I failed to find fossils in the Waipara beds at Redcliff; but at Broken River, beds 2, 3, and 4 have fossil shells quite conclusive as regards their identity with the Waipara beds, *Conchithyra parasitica* and *Inoceramus* occurring, in addition to many others.

Referring to the relations between the Weka Pass calcareous green sands and the underlying Amuri limestone, I may observe that wherever the one is present the other also appears, except near the Hurunui Bridge, and that instance either may or may not be evidence of unconformity. No doubt there is a considerable difference in the character of the fossils found in the calcareous green sands and those in the underlying Saurian beds, but, even admitting the conformity between them, this is to be expected. Stratigraphically, I could find no conclusive evidence of unconformity; and, if the Weka Pass calcareous greensands belong to the lower Waipara beds, no unconformity can be conceded as far as the uppermost beds of the Mount Brown series.

At all points where the Weka Pass beds are overlaid by any higher beds, the marly grey or green beds are the next in succession, and in many places they pass insensibly from one to the other. This gradual passage may be observed in Weka Creek, near the hotel, at the lower end of the Pass, and is beautifully illustrated in the southern branch of the Waipara, in the Heathstock district, characteristic fossils being found in the passage beds.

Collections from these marls were made in the Weka Pass and at the Upper Waipara, and in the sections between Mount Brown and the junction of Bobbie's Creek with the Waiapara, in all of which localities the evidence of conformity to the calcareous green sands was quite conclusive. Neither at Redcliff nor in the Trelissic Basin could I find these marls or their characteristic fossils, and from Culverdon they seem to be also absent.

Although occurring in the southern branch of the Waipara, near its junction with the northern branch, no tertiary rocks are found to overlie the Saurian beds in Bird's Eye Creek, nor in the vicinity of Lee's Pass, leading from the Waipara to the Okuku country.

From what I have since learned, tertiary rocks appear to occur in the Upper Ashley; but, unfortunately, when in the Okuku country unfavourable weather prevented my reaching so far. It remains but to say that I made collections from the Culverden beds, which consist of three distinct limestone beds, separated by volcanic tufus and lava streams. In the lower of these limestones fossils are plentiful; in the middle they are of rare occurrence; the upper limestone again abounding in fossils. The limestones at Marble Point occur under precisely the same conditions, and the fossils are the same, the whole appearing to belong to the Mount Brown series, and I have no hesitation in saying that they are younger than the grey marls.

Before entering upon that part of this report which relates to the West Coast of the South Island, I wish to point out the existence of fossiliferous Triassic limestones on the Okuku Range, dividing the Waipara from the Okuku River, and highly fossiliferous in The Brothers, two hills on opposite sides of the latter river where it leaves the higher ranges. The beds on which the Redcliff outlier rests are also fossiliferous, having in them the *Annelid* of Mount Torlesse, the same beds also appearing to correspond with the fern beds at the Clent Hills.

On passing from the East to the West Coast of the South Island, I found that the time at my disposal would not admit of my visiting all the localities mentioned in my instructions, and I was only able to trace (not continuously) the coal series from the junction of the Inangahua with the Buller, up the valley of the last mentioned river as far as the Owen and Hope Rivers, from which point younger beds, consisting chiefly of conglomerates, prevail as far as Foxhill, on the road to Nelson.

The general sequence of the coal-bearing strata on the West Coast may be classed as follows:—

1. Cobden limestone and higher beds where present.
2. Black marls, the true *Pecten zittelli* beds.
3. Sandstone (Island sandstone).
4. Grits and sandstone.
5. Coal.

Local divergences, from their generally persistent character, occur in all of these divisions, rendering identification sometimes a matter of difficulty.

At the junction of the Inangahua River with the Buller, dirty coloured *Nummulitic* limestones occur, overlaid by gritty sandstones; these, in turn, are succeeded by marly beds that appear to be the equivalants of the *Leda* beds, as they are overlaid by the Cobden limestone, with its characteristic fossils.

This *Nummulitic* limestone can be traced up the Buller till within two miles of the Lyell, where it is found associated with coarse grit and seams of coal. Fifteen miles higher up the Buller, this limestone again makes its appearance on the roadside, near White's accommodation house, resting on the granite, and followed by what appear to be the *Leda* marls.

Although from this point, to a little above the junction of the Owen River with the Buller, the coal series is nearly continuous, the only complete section to be obtained occurs at the lower end of the Four River Plain, where, in a high table-topped mountain, the sequence is complete from the Cobden limestone to the coal beds, the whole forming a syncline, and showing the coal on the western side, at the junction of the Maruia River with the Buller. The sequence at this point is as follows :—

1. The Cobden limestone forms the top of the mountain, which is surrounded on all sides by high precipitous cliffs of these rocks.
2. Dark marls, followed by the Cobden limestone.
3. Sandstones, the lower part thick bedded and gritty, the upper part flaggy and fine grained, having abundance of dicotyledonous leaves.
4. Dark sulphurous marls with small nodules of ironstone. These beds of marls contain *Echinoderms*, and appear to be the equivalents of the *Leda* marls.
5. Clearly stratified sandstones, with large concretions.
6. Coarse irregular gritty sandstone, with irregular seams of coal.

Further up the Buller, the lower sandstones—5 and 6 of this section—are largely developed, and are contained in a syncline, which dips at a very high angle, the rock often being a coarse conglomerate, with sandstone and shales between, crowded with dicotyledonous leaves. Near the junction of these rocks with the granite in the upper part of the Owen River, grey calcareous shales and *Nummulitic* limestones are found, which may be considered as the equivalents of those mentioned as occurring at the junction of the Inangahua with the Buller River. The coal rocks are further traceable into the valley of the Hope River, until they are overlaid by the heavy conglomerates of young tertiary age, which extend from here, without interruption, as far as Foxhill. At Stoke, near Nelson, and in the railway cutting, Jenkin's Hill, *Leda* marls with characteristic fossils are found, underlaid by coarse sandstones and coal seams from the latter place. I made a fair collection of the fossil contents of these beds, and also from the younger beds of the Port Hills.

In passing the Wairoa River, I made a small collection from the Triassic beds at that place, but was unable to find anything not hitherto described.

During the course of these examinations I have thus been able to ascertain—

1. That no remains of *Plesiosaurus* can be traced higher than the green sands of the Waipara beds, their occurrence in the Weka Pass beds not being proved.

2. That, although the fossils differ considerably in the Weka Pass beds and the lower Saurian beds, no unconformity can be detected in the strata.
3. That there is no appearance of the Lower Amuri series being present in any part of the district examined.
4. That in the Heathstock area neither the Saurian nor younger tertiary rocks cross the Okuku Range, or appear in the valley of the Okuku River, but younger or tertiary beds appear to occur in the Upper Ashley.
5. That the grey marls are quite conformable to the Weka Pass stone.
6. That at Culverden only tertiary rocks of the Mount Brown series are found, and this applies also to Marble Point, the fossils there agreeing with those found in the Culverden beds.
7. That Trelissic rocks are found in the Okuku Range, behind Mount Grey and in the Brothers, near the upper gorge of the Okuku River.
8. That certain conglomerates and shales at Redcliff strongly resemble the fern beds at Clent Hills, and contain in their lower beds the *Annelid* of Mount Torlesse.
9. That the lower beds of the Trelissic Basin contain *Conchithyra parasitica*, *Inoceramus*, etc.
10. That on the West Coast of the Middle Island the only horizon to be recognized with certainty is the *Pecten zittelli* or *Leda* marl, between which and the coal beds no limestone resembling the Weka Pass or Amuri limestone is to be found.

Whether the strata intervening between the *Leda* marls and the coal on the West Coast find their exact equivalents in the Waipara Saurian beds, the evidence is not yet sufficient to decide.

REPORT ON COUNTRY BETWEEN CAPE KIDNAPPERS AND CAPE TURNAGAIN.

BY A. McKAY.

To accompany Map and Sections.

Instructions to Mr. McKay by Dr. Hector.

Wellington, 4th January, 1875.

YOU will be good enough to proceed to Napier, for the purpose of making a geological examination of the country between Cape Kidnappers and Cape Turnagain.

1st March, 1875.

I HAVE the honour to report that, in accordance with instructions, I have examined the coast line of the Province of Hawkes Bay, from Cape Kidnappers to the southern boundary of the Province.

Landing at Napier, I went by way of Havelock to Waimirima, on the mainland, opposite Bare Island, where secondary rocks, in many respects identical with the oil-bearing rocks of the Poverty Bay and Waipawa districts, occur. In that part of the district at present under review, the area of secondary rocks is but of small extent, the principal mass, that opposite Bare Island, being but four miles long from N. to S., and about 2½ miles wide in an E. and W. direction, a long narrow strip of the same rocks being prolonged from its south-western boundary, down the valley of the Te Apiti Creek, and disappearing under tertiary beds half a mile from the sea. The cliffs of the coast line also show the secondary rocks underlying the tertiary beds, which, as shell limestone, cover the underlying strata. Three miles north of Waimirima, secondary rocks appear in the sea cliffs, and about a mile and half further north another small outcrop is seen, and they again make their appearance in a small patch cropping out on the right bank of the Tukituki River, two miles above McLean's station.

The formations in this district may be classed as secondary, cretaceo-tertiary, and tertiary. The first includes the following members, in ascending order:—

1. Sandstone and shale, with *Inoceramus.*
2. Grey concretionary sandstone and cone-in-cone limestone.

3. Contorted sandstones, with *Scalaria* and *Inoceramus*.
4. White siliceous rock, brecciated with green sands.
5. Green sands and black shales, with flattened tubes and shell fragments.
6. Chalk marls, with cement stones.

Between 3 and 4, crystalline igneous rocks are found.

The beds considered as cretaceo-tertiary are—

7. Tufaceous green sands, with dark sandy clays.
8. Clay, or chalk marls, without concretions.
9. Sandy marls.
10. *Nummulitic* limestone, with *Pecten*, *Ostrea*, *Waldheimia*.

The tertiary beds are lower, or Hawkes Bay series.

11. Calcareous sands and shelly limestones (*Cucullæa* beds).
12. Brown sandstone.
13. Marly clays.
14. Blue sandy clays.
15. Shell limestone (Napier beds).

Upper, or Wanganui series.

16. Coarse conglomerates.
17. Sandy clays, highly fossiliferous.
18. Conglomerates.

Clear and trustworthy sections are very rare in the sea cliffs, gigantic slips generally forming the coast line, the ground being disturbed in some cases as far as half a mile inland, the whole being, during wet weather, in constant movement. The best section of these rocks is seen along the shore, from Waimirima Bluff to near the mouth of the Mokomokoura. The lowest rocks (No. 1) seen are thin bedded sandstones and dark shales, slightly greenish in colour, and full of *Inoceramus* shells, but which, from the fragile character of the shales, are very difficult to get out in a complete state. Near the point of the Bluff these sandstones and shales are overlaid by a grey sandstone (No. 2) in the upper part of which large concretionary sandstone boulders occur.

Higher in the section these beds pass into bed No. 3, which are composed of conglomerates and shales, beds of sandstone and concretionary boulders, with masses of cone-in-cone limestone adhering to them. Overlying these, and marked No. 4 on map, are green sandstones, sometimes soft like green sands, and having many white pebbles intermixed. A white chalky-looking rock, probably a siliceous one, forms a long reef in the sea, and along the strike of the beds rises as craggy knobs or bold scarps. Green sandstone and this white rock form the remainder of the section.

From the calcareous concretions derived from bed No. 4, I procured a different species of *Inoceramus* to that found in bed No. 1, but it was the only shell to be found in them.

In the first outcrop on the coast north of Waimirima, no fossils were found, but the occurrence of green sandstone, cone-in-cone limestone, and contorted sandstones were sufficient to identify it as belonging to the secondary rocks.

The next outcrop further north yielded, in the above-mentioned rocks, *Inoceramus* shells as fragments, and a fragment of a large *Ammonite*, which, although I removed to a considerable distance beyond high-water mark, was, by the undermining of the cliff, swept into the tideway and lost.

The outcrop in the bed of the Tukituki shows in the banks of the river only, and is composed of bed No. 4 or No. 5. The strike in the Waimirima section, to which all the rest nearly conform, is N. 20° E., dip usually from 45° to 55°, and, as a rule, to the westward. Univalve fossil shells are found in bed No. 3, with large quantities of *Inoceramus* shell broken into small fragments along the beach to the south of the Waimirima Bluff, as far as Red Island.

Red Island, which is situated two miles south of the Waimirima Bluff, is in reality a small peninsula, connected with the main land by a narrow ridge of beds, No. 3 or 4. The so-called island itself is of igneous origin, and is in some parts crystalline in structure, and at others amygdaloidal; it is green when freshly broken into, but weathers brown or red. The shales and sandstones which underlie the igneous rocks at this point may belong either to No. 1 or 3, probably the latter. The strike is nearly E. and W., and the dip S.

A quarter of a mile south of Red Island, green sand and the black shales of Awanui make their appearance, the black shales containing the same fossil as at Awanui, viz., long flattened tubes.

The coast line further south, as far as secondary rocks are seen at all, shows beds Nos. 1, 2, and 3, and on the ridge of hills inland Nos. 4 and 5 appear. Masses of tertiary limestone lie scattered over the surface of the secondary rocks, often to a considerable distance from where any body of that rock appears *in sitû*. Tertiary limestones cap the coast range four miles south of Waimirima, and continue from there to the sea at the mouth of Te Apiti Creek; but the valley intervening between this point and the main body of tertiary rocks to the west exposes secondary rocks belonging to beds Nos. 3 and 4, which are last seen at Mr. Brown's homestead, near the mouth of Te Apiti Creek.

Between Te Apiti Creek and the mouth of the Mangakuri a reef appears, forming small islets, and seems to be entirely composed of the igneous rocks of Red Island, the beach being covered by boulders of the same rock, although the mainland is of tertiary age, and contains no such rock as that which composes the boulders.

From the mouth of the Mangakuri River secondary rocks are found along the coast as far as Paonui Point. At the mouth of the Mangakuri coarse conglomerates occur, with broken *Inoceramus* shells and a univalve resembling *Scalaria.* The beds here lie at a low inclination, dipping to the eastward, the strike being N. 20° E. Large sandstone concretions are common along the beach until reaching a point three miles south of the Mangakuri River, where great masses of white rock and green sandstone prevail, showing the presence of bed No. 4. These dip along the coast for three miles south of Mangakuri to E., and the beds often lie at a high angle.

On passing inland I found that on the western side of the coast range, from opposite the Mangakuri station to Paonui Point, the secondary rocks prevail, all dipping to the west, and alternations of beds Nos. 3, 4, and 5 occur as they are followed westward, forming, at Rangatira, a mountain about 2000 feet high. I was unable to make out the western boundary of the secondary rocks, but it is almost certain that they are connected with the Castle Range at Omakare Creek, in which the white rock and green sandstone are the only rocks seen. The Castle Range is flanked both to the east and west by chalk marls containing beds of *Nummulitic* limestone, and is connected with the secondary rocks, which, beginning on the coast about two miles south of Black Head, are continuous on the coast line as far as Cape Turnagain, where tertiary beds again appear, the secondary rocks being only seen to the south of this point, and continuing until Castle Point is reached. The boundary of the secondary rocks, on the western side, I did not determine, only ascertaining that they reached eight or ten miles inland, and between Black Head and the southern boundary of the province exhibit chiefly beds Nos. 4 and 5, forming an anticline, along which the Mangamaire stream flows; the whole of the hills from there to Cape

Turnagain being covered by a hard grey sandstone, which seems to be a mixture of quartz sand and green sand.

At the mouth of the Pourerere River two small outcrops of secondary rocks occur, composed chiefly of green sandstone and contorted sandstones.

At Paonui Point the igneous rocks are seen as a brownish band, in bed No. 3, near the point of junction with the *Nummulitic* limestones, which, with the overlying beds, form Paonui Point.

CRETACEO–TERTIARY ROCKS.

On the coast, four miles north of Waimirima, are dirty-coloured green sands with dark sandy shales, lying quite unconformably upon the secondary rocks, and striking S. 20° E., with a dip of 25° to the N.E. Further south the dip is much less, and the greensand tufa is absent, but marly beds, grey when dry, dark coloured and slightly greenish when wet, appear dipping gently to the east, and apparently underlying the greensand tufa. It is the only rock seen here. These beds contain a coral *Turbinolia*, common in the calcareous greensands of the Weka Pass and Waipara districts, Canterbury; also a *Waldheimia*, *Voluta*, sharks' teeth, and some *Nummulites*. But with the exception of the corals and *Waldheimia*, fossils are rare. As the green tufaceous beds are seen only on the coast, from the similarity of the material forming the beds it is very difficult to make out the junction between them and the overlying tertiary beds. A difference of strike and dip is observable between these and the beds three miles south of Cape Kidnappers; but, as they are six miles removed from one another, a comparison, as far as this is concerned, would have no value.

I have referred to the same age as these beds certain *Nummulitic* limestones and calcareous marls which cover a considerable extent of Messrs. Nairn's run and the valley of the Waiwera stream, west of Castle Range. The evidence is far from conclusive that they are the same beds; but, as the marly beds are somewhat similar, and in both localities *Nummulites* are plentiful, for convenience sake I have coloured them the same.

At Paonui Point, *Nummulitic* limestones occur lying on the old denuded surface of the secondary rocks (beds Nos. 3 and 4), and, strangely enough, dipping quite in the contrary direction to the marls with concretions which immediately overlie them. This limestone is almost entirely composed of microscopic shells, though frequently mixed with gravel and angular pieces of rock. Although here these beds are in contact with the older rocks, lying uncomformably upon them, near the source of the Pourerere River, sandy marls and beds—which on the western side of the Castle Range strongly resemble the *Leda* marls of Wangape Lake—intervene, and contain abundance of *Nummulites*. These beds near the mouth of the Pourerere River have either been much disturbed, or, in conforming to the unequalities of the old surface on which they are deposited, vary much in their strike and dip.

TERTIARY BEDS.

Overlying the *Nummulitic* limestone is a calcareous sand, which in places is almost a loose sand, and in others a hard limestone. This bed contains a considerable variety of fossils, which appear to agree better with the Taipos, on the East Coast of Wellington, than with the Castle Point or Napier beds. No distinct unconformity exists between these beds and the underlying *Nummulitic* limestones; but, being distinctly tertiary beds, I have here drawn the line, parting them from the *Nummulitic* limestones and marls, which resemble the *Leda* marls, containing *Pecten zittelli* and *Dentalium tenuis*, neither of which, however, appear to be present in the *Nummulitic* beds here. This calcareous sandstone is overlaid by a brown quartzose sandstone, varying from a few feet to 40 or 50 feet in thickness, and containing concretions, but no fossils. Marly beds, weathering to a light brown colour, follow these in the Pourerere section, and have large fine-grained concretions.

A little south of Pourerere these beds strike N. 30° E., and dip S.E. 20°, the higher beds being exposed as the coast is followed south, until, at a distance of a mile and half north of Black Head, occassional masses of Napier limestone, containing the large *Panopæa*, occur on the beach. On the south side of Black Head the strike changes to S. 25° E., dip 25° N.E., and the rock has more the appearance of the *Nummulitic* beds, but contains no fossils. For some distance before reaching the Napier limestones the marly beds with concretions change to blue sandy clays without concretions, which, save near Black Head, contain no fossils, they being scarce even there.

Between the mouth of the Mangakuri River and the point two miles north of Te Apiti Creek, the Napier shell limestones form bold cliffs along the coast, dipping W., and exposing at their base the sandy clays mentioned as occurring north of Black Head. From the mouth of Mangakuri, west to the Tukituki River, and north till opposite the crossing of the latter river on McLean's run, opposite Havelock, all the high lands are covered by Napier limestone, having generally a slight westerly dip, and, where it is cut through by the creeks, showing the blue sandy clays underlying. This limestone occupies the whole area above mentioned, save where the secondary rocks appear at Waimirima and again crop out over a small area on the coast four miles to the north of this point.

Certain loose gravels are reported to occur on the top of Mount Kauranake, the highest peak in the district, which would seem to represent the coarse conglomerates that overlie the Napier limestones in the Cape Kidnappers section.

North of the last outcrop of the secondary rock, on the coast between Bare Island and Cape Kidnappers, are dark sandy marls with great quantities of concretions similar to those contained in the tertiary beds at Pourerere. They, however, contain no fossils, and, not being able to make out any stratification, I could not determine to what series they belonged, although they probably overlie the *Nummulitic* limestones, and form part of the sandy clays and concretionary marls that intervene between the Napier limestones and the *Cucullæa* beds, as seen at the Taipos, further south in the Province of Wellington.

Three miles south of Cape Kidnappers the hills approach the coast, and form a high bluff composed of soft grey sandstone with large concretionary masses. These beds are distinctly stratified, and strike S. 20° W., dip N.W. 15°, and from here to Cape Kidnappers the beds remain similar in character, and contain a few fossils resembling those of the middle Akuaku beds, fan corals, *Dentalium*, and a volute being the more common.

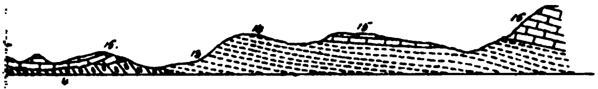
After passing the Cape, and proceeding along the shore, large shells, *Pecten*, *Pectunculus*, etc., appear; and, at a point one and a half miles inside the Cape, these beds pass into the Napier limestone, which contains at this point numbers of *Arachnoides zealandia*. Overlying the Napier limestone is a thick bed of coarse conglomerate, having the same general strike, but the angle of dip is less. These conglomerates alternate with beds of sand, and form high cliffs along the shore, extending to the Mariatotara River. In the finer beds pieces of pumice are often seen, but they are entirely absent in the coarser conglomerates, which are chiefly composed of sandstone, but in no way resembles the secondary rocks at Waimirima, being probably derived from rocks of greater age. Two or three thin beds of inferior lignite, with stumps of trees, may be seen about two miles before reaching the Mariatotara River, where also sandy clays, with a great abundance of fossil shells, occur—the ordinary mussel and cockle being very prominent. These sandy beds are again overlaid by conglomerates—the pebbles in which are much smaller than in the underlying conglomerates—and these appear to be the highest beds of the series. They terminate about two miles up the Mariatotara, and to the westward, and are last seen on the banks of the Tukituki, where they form cliffs and low hills on the right bank of the river, opposite Mr. Chalmers' station. I refer the conglomerates said to occur overlying certain limestones some miles up the Tukituki River, on Mr. Cooper's run, to the same horizon.

At Cape Turnagain the blue sandy clays—without, or with only a few, concretions—are overlaid by a thick bed of Napier limestone, which is easily recognized, although lying at some distance from any beds of the same age. Their strike is N. 10° E., and they dip 35° to 40°; but near the junction with the secondary rocks, at the Cape, they lie in a nearly horizontal position.

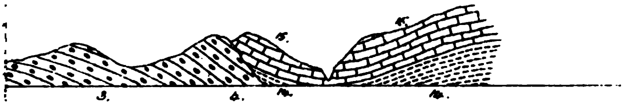
No rocks other than secondary are found on the coast between Cape Turnagain and Castle Point, the rocks and fossils of which latter place agree perfectly with those I have already described as the Napier limestones, and underlying blue sandy clay.

From Cape Turnagain to Castle Point, I followed the shoreline where practicable, and found the strike north of Akiteo River, as far as the boundary of the Wellington Province, to be N. 10° E., forming a somewhat abrupt anticline, which exposes in its centre and at its eastern wing beds Nos. 1, 2, 3, and 4. Small concretions of cone-in-cone limestone occur in No. 1, which do not appear in the Waimirima section. Beds Nos. 2, 3, and 4 form the ranges along the coast until Mount Percy, seven miles north of Castle Point, is reached, where black shales with flat tubes occur.

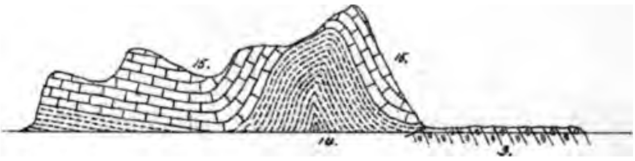
On the shore at this point are found glance sandstone concretions (Roparua boulders), this being the furthest point south where I have been able to recognize them. At Castle Point, and on the coast for some miles south, bed No. 3, and probably bed No. 1 (but without fossils), are the only rocks seen; but, on following the creeks inland two or three miles, green sandstone, black shales, and chalk marls with large brown concretions, occur, such as distinguish these beds at Poverty Bay and Awanui. Crystalline igneous rocks are also found in the Station Creek, two miles west of Castle Point. The strike of the secondary rocks in the neighbourhood of Castle Point is N. 20° E.; dip, high and irregular, but, on the whole, to the west, until reaching



NORTHERN BOUNDARY OF TE APITI RUN



MOUTH OF MAUNGAKURI RIVER.



CASTLE POINT

SECTIONS - HAWKES BAY

1 Sandstones and Dark Colored Shales
2. Grey sandstone with concretions (Cone in cone beds)
3. Contorted sandstones and Conglomerates
4. White siliceous rock, often brecciated
5. Greensandstone and Black Shales
6. Chalk Marls
6a Crystalline and Amygdaloidal Igneous rocks

7. Tufaceous Greensands
8 Clay or Chalk Marl
9 Marly Beds
10. Nummulitic Limestone

11. Calcareous sands
12. Brown sandstone
13. Marly Clays with fine grained concretions
14. Blue sandy Clays
15. Shell limestone (Napier Beds)

16. Coarse conglomerate
17. Sands + Clays - Lignite Beds
18. Conglomerates

w Zealand.

DIRECTOR.

January 4, 1875.

the watershed dividing the creeks that flow in an easterly direction from those that fall into the Tinui River, where the dip changes to the east, the uppermost beds which appear in the syncline being the chalk marls of Awanui, with occasional masses of green sandstone; the lower beds not making their appearance until reaching Maunsell's, where the Taipos and the conglomerates of bed No. 3, with broken *Inoceramus* shells, make their appearance. Between Maunsell's and Morrison's Taipos, the *Inoceramus* beds cross the Whareama River, and they are found on the low hills by which the track reaches the valley of the Mangapakia; this being the furthest west that I could trace them. Fragments of *Inoceramus* shells occur here in a reddish rock, which is the same as that occurring at Paonui Point and at Red Island, and possibly owes its colour to the presence of the igneous rocks.

I made a small collection at Mansell's Taipos, the beds overlying which are the same as those intervening between the Napier shell limestones and the calcareous sandstone at Pourerere, immediately overlying the *Nummulitic* beds. Between Pourerere and Black Head, these beds have in their lower part many concretions; but the higher beds, beginning at Vallence's station, on the Taueru River, are without concretions until just passing into the Napier limestones, where elliptic masses, composed chiefly of shell casts, are found. Succeeding these beds are shelly limestones—in fossils, as well as in character similar to the Napier limestones—which form the highest bed of the series.

After making a collection from these beds, I returned to Wellington, by way of Masterton.

As all the collections have not yet arrived in Wellington, I am unable to add the number of specimens collected by me from the different localities where such were made. Those that have arrived are as follows:—

Collected by Mr. Enys—		
From the tertiary concretionary marls, Pourerere	59	specimens.
From the secondary rocks, Akiteo ...	14	,,
	73	,,
Collected by Alex. McKay—		
From secondary rocks, Pourerere ...	25	,,
From *Nummulitic* limestones and underlying beds, Paonui Point, Omakari...	18	,,

From calcareous sandstone, south of the main branch of the Pourerere ...	186	specimens.
From Mansell's Taipos	31	„
From Napier beds and sandy clays immediately underlying, ten miles east of Masterton, on the Taueru River, Castle Point Road	300	„
	560	„

Collections are yet to arrive—

From Waimirima	1	box.
„ Te Apiti	1	„
„ Castle Point	4	„

From the secondary, two species of *Inoceramus* and a *Scalaria* were all the distinct shells that I could secure.

List of prominent shells in the *Nummulitic* limestones, Paonui Point and Pourerere River.

1. Fragments of large oyster.
2. Small *Pecten*, ears unequal, and ribbed.
3. *Waldheimia concentrica*.
4. *Nummulites*, forming nearly the mass of the stone.

Calcareous sandstones, with *Cucullæa*, Taipo beds—

1. *Dentalium*.
2. *Strutholaria cincta*.
3. „ *senex*.
4. *Turritella gigantea*.
5. *Voluta corrugata*.
6. *Veniricardia*.
7. *Cucullæa alta*.
8. *Lucina divaricata*.
9. *Crassatella trailli*.
10. *Rhynchonella nigricans*.
11. *Waldheimia*.
12. *Modiola*.

Taipos, East Coast, Wellington—

1. *Turritella gigantea*.
2. *Natica*.
3. *Pectunculus*.
4. *Ancillaria*.
5. *Struthlaria*.
6. *Voluta*, etc.

List of prominent shells from beds underlying the shell limestones, Taueru River, Masterton.

1. *Strutholaria*, species not described.
2. *Calyptræa maculata.*
3. *Panopæa.*
4. *Pecten secta.*
5. *Pecten.*
6. *Pecten.*
7. *Lucina divaricata.*
8. *Carbula dubia.*
9. *Venus.*
10. *Ostræa*, etc.

With these are many other shells which require to be more or less worked out previous to determination, but the above will sufficiently indicate the relations the beds bear to others containing similar fossils.

REPORT ON TERTIARY ROCKS AT MAKARA.

BY A. McKAY.

3rd March, 1875.

ON the 2nd instant I visited the small patch of tertiary rock at Printer's Flat, Makara Valley, where, a quarter of a mile beyond the church—that is, further down the valley—fine-grained conglomerates crop out in the creek bed on the upper side of the road.

In this conglomerate a considerable number of broken shells and fragments of corals occur, their broken state rendering them very difficult of identification. I was only able to obtain fragments of a thick-shelled oyster, some casts of *Waldheimia*, and two kinds of coral, all of which are found in the Napier and Castle Point beds, and which lead me to suppose that this outlier belongs to the same formation.

I brought with me 16 specimens of the rock, containing fossils in a more or less distinct condition.

I was also induced to visit a quartz reef, supposed to contain gold, and situated on a spur on the east side of the valley. Iron pyrites is plentiful in the stone, and forms a lode half a chain lower down the spur from where the quartz crops out. No gold was visible in the stone; but, at the request of the prospector, I brought specimens to be tested. Both the quartz and the underlying pyritous reef appear to correspond in strike and dip with the sandstones and shales with which they are associated. The strike is N. 12° E., dip E. 70°, the hard ridge of flinty quartz forming a feature traceable over several spurs in succession.

REPORT ON WANGAROA NORTH.

BY A. McKAY.

To accompany Map and Sections.

Instructions to Mr. McKay by Hon. W. B. D. Mantell.

11th May, 1875.

You will proceed north to-morrow, per Taranaki, and make your way, with as little delay as possible, to Totara, Wangaroa, to examine the coal-bearing strata there. Mr. G. T. Ferguson, of that place, will, I doubt not, give you every facility for a satisfactory examination. You will make, and forward hither, collections illustrative of the district, and return with as little delay as circumstances will permit.

Mr. Buchanan informs me that you have with you a map of Wangaroa and the surrounding country; and I forward by this mail Hochstetter's map and explanatory pamphlet, which you may find useful in the Auckland district.

Note left by Dr. Hector.

"I WISH Mr. McKay to proceed to Wangaroa, and endeavour to trace the outcrop of coal in the Kaeo Valley, and to discover its relations with the Mesozoic strata which occur there, and to connect it with the coal field which is worked at Kawa Kawa, Bay of Islands.

After this he will proceed to Mahurangi, and, noting the unconformity between the *Nummulitic* limestone and the underlying brown and green sandstones, endeavour to find some evidence of the age of the latter, and to discover their relations to the sandstones at Helensville, and the relation of the latter to the Waitemata beds of Hochstetter, as developed on the north side of Auckland Harbour."

16th June, 1875.

I HAVE, as directed by instructions dated 11th May, 1875, visited Wangaroa, and examined the coal-bearing strata at Totara Point, and also a seam of coal lately discovered near the source of the Kaeo River.* I have also made collections of fossils and rock specimens, illustrating the district examined.

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* **For geology of this district, see *Hector*, Geol. Rep., 1872, p. 153.**

The oldest rocks seen by me are of secondary age, and are identical, both in mineral character and fossil contents, with the secondary rocks found along the East Coast of the North Island, between Cape Kidnappers and Castle Point.

These rocks cover a considerable area of country to the south and east of Wangaroa Harbour, and, where seen on the borders of the harbour, consist of conglomerates, sandstones (sometimes calcareous), and shales of a dark greenish or black colour, with large concretions and masses of cone-in-cone limestone.

On the eastern side of the harbour a blue siliceous fine-grained rock, weathering white, and which seems to be the higher beds of the series, is very prevalent. It is generally characterized by its extreme whiteness, and the occurrence in it of singularly clear and sometimes perfect quartz crystals.

It is in these rocks that the principal part of the prospecting for coal has been carried on, and near Totara Point a shaft and several bore-holes have been put down, some of them to a considerable depth, but hitherto no coal of any consequence has been discovered.

In all cases these works have been carried on in the black shales, and in no case seem to have reached the underlying strata.

As the beds dip at an angle varying from 35° to 70°, the greater part of them lying at the higher angle, coal, if present in paying quantities, ought to make its appearance along the west bank of the Iwitawa, or in the creeks reaching the harbour from the west.

The only indications of coal which I could find were very small pockets in the conglomerates at Cape Horn Point; and in the overlying sandstones thin layers of broken and carbonized plant remains occur, which are sometimes sufficiently thick to show a thin streak of coal.

The workmen report cutting a thin seam of coal, 3 or 4 inches in thickness, at some depth, in a bore-hole close to the beach; but I could discover no signs of anything so thick at the surface.

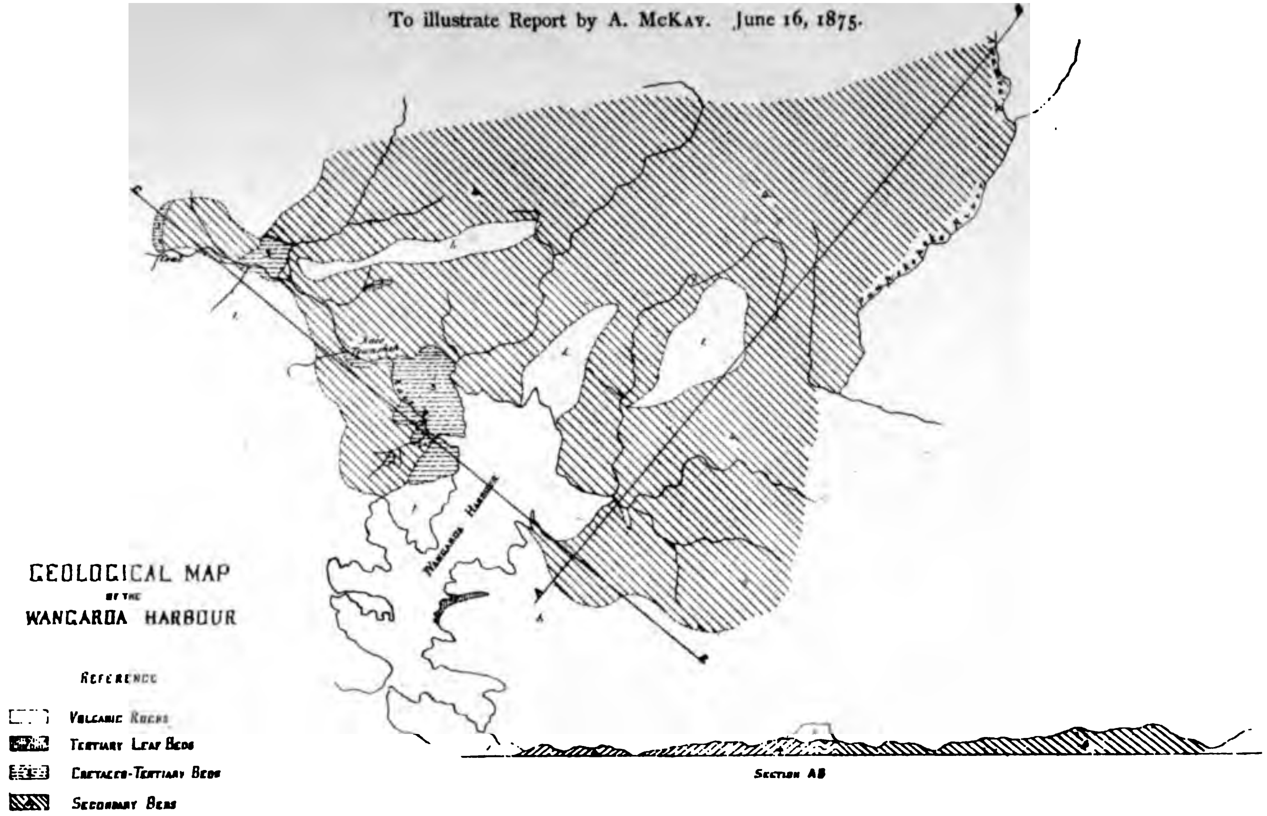
The general strike of the beds is S. 50° W., dip 35° to 70° N., exposing the lower members of the series in the head of the Iwitawa Creek, where the rocks are much contorted and have a serpentinous look in parts. They still, however, contain the same fossils; cone-in-cone limestone, some barytes, and not unfrequently masses of grey flint.

At the head of the harbour (south end) the rocks are chiefly shales weathering to a dirty brown colour, and frequently covered

Geological Survey of New Zealand.

JAMES HECTOR, M.D., F.R.S., DIRECTOR.

To illustrate Report by A. McKay. June 16, 1875.



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by an efflorescence of sulphur; they contain, besides the ordinary calcareous concretions, frequent masses of cone-in-cone limestone. The strike and dip at this point are not easily made out, but seems to be east and west, with a dip to the north. South of Taratara there is an isolated table-topped mountain, two miles south of the upper end of the harbour, where these rocks are largely developed, and, although volcanic rocks overlie them in some places to a considerable extent, they may be said to extend uninterruptedly from the harbour to the Koeo Township, and thence up the south bank of that river until they are finally overlaid by the volcanic rocks at the source of that river. On the Awanui stream, a branch of the Paupokopoko River, oil shale has been discovered, which induced me to visit the locality, and from the bed of the stream, in the same neighbourhood, I procured some clay iron ore, but could not discover its source.

Fossils are found in these rocks at the south end and west side of the harbour, both in the shales and in the large concretions washed out of them. The *Inoceramus*, common on the East Coast of Wellington, is the most abundant fossil, the others being mostly new forms peculiar to the locality. On the east side of the harbour the secondary rocks are overlaid unconformably by green and brown sandstone, in which a great abundance of fossils is found at several places. The same rock occurs in lesser patches at short intervals all along the Kaeo River to its source, near which it is overlaid by volcanic rocks, which spread nearly continuously over the plains beyond.

Near the source of the right-hand branch of the Kaeo River, coal has been discovered, but hitherto only as broken masses in a slip. I visited the place in company with the prospector, but the excavations had fallen in, and little could be seen. It was clear, however, that no *seam* of coal had been found, but only scattered pieces in the loose *débris* and slope deposits, which consist mainly of brown and green sandstone.

The lumps of coal occur in a black clay, and close to the underlying secondary rock. At the crop this black bed was very thin, and only small pieces of coal were found; but, on being wrought into, the thickness of the coal increased to 20 inches, the pieces being larger and the quantity greater, but the furthest point reached showing no signs of a solid roof.

The locality surrounding this slip was carefully searched for the coal *in sitû*, but without success, though there can be little doubt that a seam of coal lies at the base of the green sandstone somewhere in the vicinity, and may be looked for at a higher level, along the spurs that lead from the Tairaire Plains into the Kaeo Valley.

Altogether, I do not think that the prospects of finding coal are sufficiently encouraging to warrant any further expense for explorations at present.

REPORT ON ARGENTIFEROUS LODE AT COLLINGWOOD (RICHMOND HILL SILVER MINE).

BY S. HERBERT COX, F.C.S., F.G.S.

16th November, 1875.

I HAVE the honour, in accordance with your verbal instructions, to make the following report on the silver-bearing lode recently discovered at Collingwood, by Mr. Washbourne*:—

This lode is found cropping out in the bed of the Parapara River, at Richmond Hill.

The river takes a sharp bend at this point, and, in its course from east to west, it cuts the following strata:—

1. Gneissic schist, passing farther eastward into steatite.
2. Slates.
3. Blue crystalline limestone, becoming white at parts, and forming the marble of the district.

It is in the gneissic schistose rock that the lode in question appears, having a strike due N. and S. magnetic. It is almost vertical, but underlies slightly to the eastward.

The general strike of the country is N. and S., with a dip of about 80° E., the lode following the same direction.†

The width of the lode is about 2 feet, but it is split up where seen into two leads; the one from which most of the specimens have been obtained having a band of 4 inches in width of the ore, in a moderately compact and solid condition, the rest of the lode being of a quality which would form good stamps work.

On the other side of the river, and about 30 feet to the east of No. 1 lode, another lode is seen, of a similar character to No. 1. At the water's edge this lode is about 1 foot thick, but it wedges out at about 12 or 15 feet up the hill to a vein of not more than 1 inch in thickness.

Both these lodes carry a good gossan of a snuffy brown colour and considerable porosity.

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* The nature and value of this ore was first detected in May, 1875, at the Colonial Laboratory, it having been sent there for analysis as an *Iron Ore*.—J. H.

† Geol. Rep., Davis, 1870, p. 135. Hutton, 1871, p. 156.

Farther to the east of No. 2. lode, again large reefs of quartz appear, not cropping out at the surface on the hill, but bared in the river bed, and, where a section can be seen above this, they break up into small leaders, which run for a short distance, appearing at the surface at a few places where the elevation is not too great. The quartz in these reefs is of a pure white, with thin veins of galena and pyrites running through them.

A low spur of from 200 to 300 feet high forms the ground round which the bend of the river takes its way, and on crossing this, in a northerly direction, a lode, similar in all respects to No. 1, is struck on the river bank, and it is in all probability the same as that which appears on the other side of the spur. At this point it is about 2 feet wide, or perhaps rather more, and appears to widen out at a very short distance below the surface, but very little has been done to prove this. Here, as on the other side of the spur, the lode carries a good gossan, the gangue of the lode being quartz. At a short distance to the westward of this lode, a change takes place in the country, and what may be called, for distinction, an elvan course comes in (this is however hardly an elvan, as it does not appear to possess the porphyritic character which these generally own), which is traversed throughout the body of it by thin veins of galena.

Another lode has been discovered farther up the Parapara, above the junction with McGregor's Creek, which is at least 6 feet in thickness. It consists of solid pyrites, and may probably be worth examining for some other mineral. This lode also strikes N. and S. magnetic, and, as near as I could make out, is vertical. It is found in the blue crystalline limestone before mentioned; and in the same rocks, close to Mr. H. Washbourne's house, a deposit of hæmatite, which appears to be a lode, shows of a thickness at least 20 feet. This may be the back of a lode of greater value than appears at the surface, and is not impossibly a continuation of the lode of pyrites last mentioned, as it appears on about the same line of strike.

With regard to the prospects of success in working the silver lode, nothing very definite can at present be said. The fact that it thins out at a slightly greater elevation than the river bed, and also that about that point the quartz reefs break up and die out into the country, is encouraging, as also is the fact that where the lode has been opened at all, which is only to a very small extent, viz., having been bared to a depth of about 2 feet, that it widens.

To prove the lode, however, a shaft will have to be sunk, and, as the outcrop at present found is close to the river, it would be advisable to drive for a short distance into the hill, or else bare the ground for that distance and then sink, so as to cut the lode at a depth, say, of 15 feet below the river level. If this were done, it would prove as conclusively as is possible in lode mining whether it were worth while proceeding with the mine or not, and the assays of the mineral found at the surface fully justify that expense being gone to with every prospect of success being attendant. It would certainly not be advisable to attempt to start a company until this had been done, as any thing of the sort would be the merest speculation, notwithstanding the favourable indications on the surface. So I must urge the necessity of further exploration.

When this lode has been proved, I think the pyritous one mentioned would also be worth sinking upon, with a view of determining its extent; and, as it is in a limestone country, great facilities in the way of natural drainage would attend its working.

The elevation of these lodes above the sea is about 500 feet, and I have no doubt that the means of transport would prove satisfactory should the value of the lodes themselves be proved.

*The Coal Mine,** which I visited before leaving Collingwood, is being worked systematically.

The lower drive is now in about 770 feet, but as yet the seams of coal, which it was put in to cut, have not been found. At 600 feet from the mouth of the drive an upcast was started, and at 17 feet from the floor of the workings a seam 2 feet thick was cut, lying above the breccia seam, and it was at first supposed to be No. 2, the seam which was being driven for.

This seam, however, being worked on the rise, was found to thin out on reaching the old level, and also proved to be below seam No. 2, and a shaft sunk from the old workings cut it at a depth of 14 feet below the old workings. Two seams have also been struck below the breccia seam, which thin out to mere dust at the outcrop.

The upcast before mentioned is now driven to a height of 60 feet above the level of the drive, and a bore-hole 13 feet long has been put in above this, but as yet with no success; the contract has, however, been let to proceed with this, and we shall, no doubt, shortly hear of No. 2 seam being cut.

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* Geol. Rep., Hector, 1867, p. 19; 1872, p. 158. Hutton, 1871, p. 157. Hector, Par. Papers, 1873, E. 10.; 1874, App. P. W. Rep.

The coal which has at present been found is being worked as follows :—A drive is put in from the main way along the strike or water level, and the coal above this, which can be worked without fear of water, is being opened up, and, to a certain extent, worked. A good system of ventilation is in progress, and the mine generally appears to be worked on a good principle.

As the mine is being worked principally with a view of supplying the furnaces when started, it is almost impossible to carry on too much tutwork for the development of the mine, as the present demand for the coal, until the completion of the furnace, will be but slight, and the advantages gained by a good system of working, which is dependent upon a proper opening up of the mine, are so great as to warrant a very considerable expense, with but a slight return at present, being gone to for this purpose.

REPORT ON WESTLAND DISTRICT.

BY S. HERBERT COX, F. C. S., F. G. S.

To accompany Maps and Sections.

Wellington, 1st November, 1875.

Memorandum of Instructions to Mr. Cox by Mr. Mantell.

YOU will proceed by the Ladybird to-morrow to Nelson, and thence to Collingwood, to inspect the lode of argentiferous galena recently discovered in that neighbourhood. Returning from there, you will be met by Mr. McKay, who, as field assistant and collector, will accompany you overland to Reefton, and you will then examine and report upon the country between Reefton and Bruce Bay, making sections of the country, at right angles to the coast line, at Reefton, Greymouth, Hokitika, and Okarito, paying particular attention to the beds forming the western flanks of Mount Cook.

You will take care to keep me imformed of your movements from time to time, by letter and telegram.

Copy of Dr. Hector's Note.

In the season of 1875–76, in the first part of the season, I wish Messrs. Cox and McKay to examine the Westland district, commencing at Reefton, and southwards along the western flanks of the Alps, making sections at intervals, at right angles to the coast, at Hokitika, Okarito, and Bruce Bay, and especially determining the western flanks of Mount Cook. Also, to examine and specially report on the coal between Arnott Point and Bruce Bay.

I HAVE the honour, in accordance with your instructions, dated 1st November, 1875, herewith appended, to make the following report on the Province of Westland, between Reefton and the Abbey Rocks, paying particular attention to the western flanks of the main ranges, and especially so in the neighbourhood of Mount Cook.

A special report on the coal measures south of Bruce Bay, together with a description of the Paureka Quarry, the property of Messrs. Arthur and Docherty, is also appended. It is from these quarries that the lithographic stone is derived which has lately been tested in

Melbourne and elsewhere, and samples of it have likewise been forwarded to the Philadelphia Exhibition.

I have also, in accordance with your telegraphic instructions, dated 31st December, 1875, to report upon certain coal discoveries at Jackson's Bay; but on this subject I shall write a separate report.

With the view of showing exactly where my observations have been taken, and where, on the other hand, the details of the maps have been filled in by inference, or from information gathered from other sources, such as previous reports, etc., I have given a description of the track we followed during our trip, which has occupied, exclusive of the time spent at Collingwood, at the commencement of November, a period of about fourteen weeks.

We arrived at Reefton 25th November, and stayed there a week, examining, during that time, the gold-bearing rocks of the district, and establishing their connection with the older fossiliferous cherts, limestones, and slates occurring there. We also examined the coal rocks of the same locality.

Having completed the above, we went up the Inangahua (south branch) as far as Rainy Creek, ascending which we followed tracks over the hills, passing through Marigig Creek and Maori Gully to Antony's Flat. Thence we descended to the Little Grey, which we followed to its junction with the Grey proper, which river we ascended for some distance. We then went on to the Ahaura, ascending this river also, and then, crossing the Grey River, went to Black Ball Creek, where we examined the coal measures, etc., occurring there. We then went up the Twelve-mile Creek to No Town, and thence on to Bell Hill, and returning to Lake Brunner we took a boat across the lake to the Greenstone Corner. We then passed through Pounamu to Goldsborough, returning to Callaghan's Hill, where Mr. McKay remained to collect, while I went on to the Christchurch Road where the Waimea Water Race crosses it. I followed the Waimea Race to its head, between Mount Turiwhati and the Island Hill, and then followed it down through the various cuttings and tunnels to Big Dam, where I left it, and went on through Goldsborough and Stafford to Hokitika, where I arrived on Christmas Eve, being met there by Mr. McKay.

From Hokitika we examined the Kanieri district, and then took the steamer to Jackson's Bay, when we remained for three days, inspecting the coal measures which I was commissioned to report upon.

We then returned, by the Waipara, to the Abbey Rocks, where we were landed January 11th, 1876. We remained at the Abbey Rocks for five days, inspecting the lithographic stone quarries and beds of the coal measures which are found there, and we then proceeded by Lake Paringa to Ward and Douglas's homestead, on the Paringa River. From here we went to the mouth of the Paringa, and also up to the Gorge, and then on to the Mahitahi and Bruce Bay.

From Bruce Bay we followed the sea line to Gillespie's Beach, whence we went up the Weheka River to the Fox Glacier, and thence over the hills on the south side of the glacier, getting on to the snow fields beyond, which lie between these spurs from The Dome and Mount Cook. We returned to Gillespie's Beach, and proceeded to Okarito, from which place we went to Lake Mapourika, McDonald's Creek, Lake Wakapo, and the River Wataroha. We then returned to Okarito, and followed the coast to the Waitaha River, from which point we ascended Mount Rangitoto, and inspected the so-called silver lode, samples of which were obtained for assay. Having completed our work here, we went on to Redman's, and examined the beds in the vicinity of the Mikonui, returning to Hokitika February 12th, 1876.

From Hokitika we took the coach up to Kelly's Creek, examined the Taipo Ranges, and, returning to Hokitika, took steamer to Wellington, arriving February 26th.

It will be observed that the route followed involved travelling over a considerable extent of country which was comparatively of little interest in the determination of the flanks of the main ranges, and that very often breaks occur between the points which have been ascertained. This was inevitable, as the country inland is so rough as to be utterly impassable, travelling as we were, and owing to the difficulty of procuring provisions in any way like accessible positions, added to which, our time was comparatively limited.

I have been careful to obtain all the information I could of various points from extraneous sources, and this, coupled with the observations which we have had an opportunity of making, will, I believe, give a better insight into the formation of the country than has hitherto been obtained. Any further explorations will have to be reserved for a time when they can be undertaken quietly, with a view of thoroughly working out in detail the whole system of the older rocks.

I have to express my thanks to the various gentlemen who have aided my work by giving me much valuable information, amongst whom Mr. C. J. O'Connor, Mr. G. Mueller, Mr. Woolley, Mr. Davis, and Mr. Wylde, as well as many others, have done everything in their power to assist me.

The rocks which occur in the district examined may be divided as follows :—

1. Recent river shingles and black sand beaches.
2. Glacial drifts.
3. Kanieri series.
4. Upper beds of coal measures.
5. Lower beds of coal measures.
6. Maitai slates and sandstones.
7. Auriferous slates of Reefton, etc.
8. Fossiliferous cherts, limestones, and slates.
9. Metamorphic rocks.
10. Granite and granitic gneiss.

Each of the foregoing divisions merits special consideration separately, and in many cases further subdivisions will have to be made in the description of their relations and positions relatively one to the other. Their special value, from a metalliferous point of view, will also have to be discussed.

Before doing this, however, it will be advisable to give a *resumé* of their general distribution over the district examined, and then to examine them separately in detail.

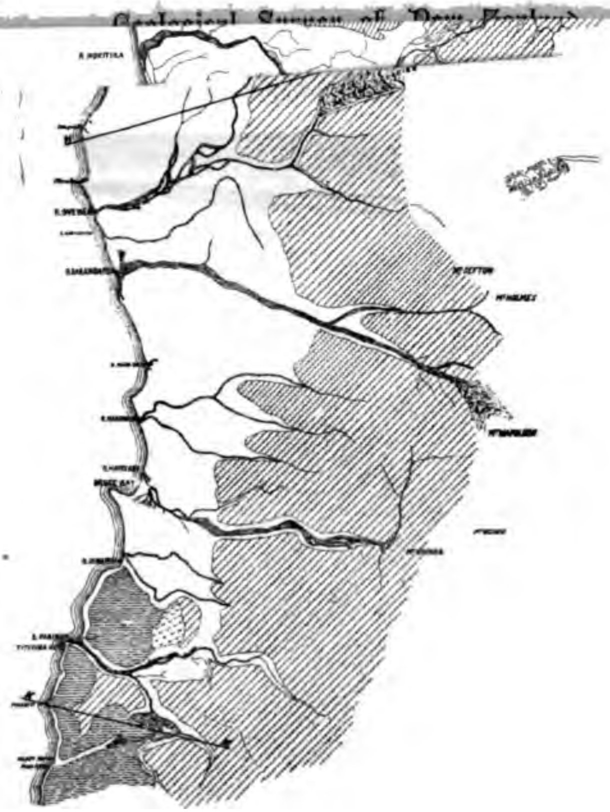
GENERAL DISTRIBUTION OF ROCKS AND CHARACTER OF THE COUNTRY.

A belt of granitic rocks strikes through the country in a N. 30° E. direction, forming a line of elevation throughout, the beds to the east of it having, as a rule, an easterly dip, and those to the westward dipping westerly.

In the district which I have examined these granitic rocks appear at the surface, forming isolated hills, the valleys between which seldom attain an elevation of more than 300 feet above the level of the sea, while the highest peak, Mount Turiwhati, is 4,506 feet in height.

They appear near where the Alexander Stream empties into the Grey River, at Granite Hill (by Lake Brunner), at Mount Tekanau, Hohuna Peak, Mount French, Mount Smart, Mount Turiwhati, Island Hill, Mount Tuhua, Frazer Peak, Mount Rangitoto, and Mount Bonar, and once more make their appearance on the northern bank of the Paringa River, forming Hunt's Hill.

Geological Survey of New Zealand



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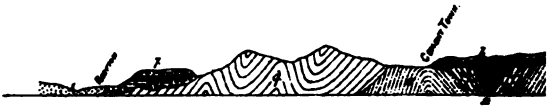

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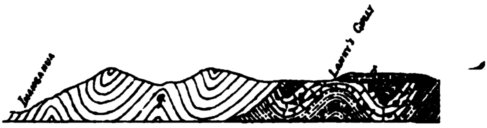

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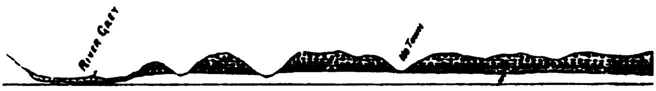

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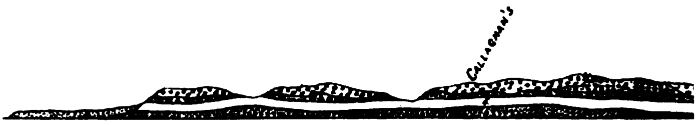

SECT

To the east of these rocks the metamorphic series makes its appearance. This series consists of frequent alternations of micaceous and chloritic schists, the lower parts of which are more or less gneissic in character. They form by far the greatest part of the main ranges lying to the eastward of the granitic belt. In their higher beds they pass into quartzites, which cover a considerable ract of country in the southern portion of the district, from Mount Cook to the Paringa River, and they probably strike through to he heads of the Landsborough and Clarke Rivers. This series generally may be traced through the country in an uninterrupted ine from the head of the Paringa Lake to the Taipo Ranges. They appear again in Mount Alexander, and must also occur urther north, judging from the river shingles; but, save in the vicinity of Bell Hill, I did not see any sign of them *in sitú* north of the Taipos. They preserve an easterly dip throughout, at a high angle, but vary somewhat in their strike, and also in the angle of their dip, at various points.

In the vicinity of Reefton certain fossiliferous cherts, limestones, and slates appear, which have no visible connection with any of he other rocks of the district.* They are lying to the westward of the granitic belt, but do not appear to abut against it, neither do they, from their position, show their relation to the metamorphic ocks. The fossils found in these beds are chiefly *Madrepore* corals, *Spirifers*, *Orthoceras*, *Orthis*, etc., and we also found two specimens which appeared to be portions of a trilobite.† With the exception of he metamorphic rocks, these are doubtless the oldest strata found n the district; but, from their isolated position, they must necessarily be described by themselves, their fossils being relied upon to determine their age, and to correlate them with other beds found elsewhere. They are found extending from the range north of the eft-hand branch of the Inangahua—which was the farthest point north to which Mr. McKay was able to trace them‡—to Rainy Creek, which empties itself into the south, or right-hand, branch of the nangahua about five miles above Reefton. South of this the beds are obscured by the overlying coal measures, and they were not again seen by us on this trip. Their strike varies between N. and N. 10° W., and the beds repeat themselves more than once.

Of L. Devonian Age, etc., unconformable below the auriferous rocks.—*Hector.* Geol. Rep., 1874., p. 86.

† *Homalonotus expansus*—Hector.

‡ Geol. Rep., 1874, p. 99.

The metamorphic rocks, then, and these older fossiliferous beds, form two distinct series, whose relative ages cannot be made out by what has as yet been seen. They are, however, probably of greater age than the granitic belt before mentioned.

Resting unconformably upon each of these, at different points, lie certain slates, sandstones, and breccias, which preserve a most constant character at all points of their occurrence, viz., the silky character of the slates. These beds are more or less tufaceous in parts, and are apparently interstratified with bands of syenite, which, save for their interbedded appearance, would seem to be intrusive in character. They are traversed by quartz reefs, striking generally a little to the west of north, and it is in these that the mines of the Inangahua district are being worked. They assume their greatest extent in the neighbourhood of Reefton, gradually dying away south, and, on reaching the Grey, they make their last appearance in one or two isolated hills, surrounded by tertiary beds. They again make their appearance further south, at Bell Hill; a small patch of them occurs at Pounamu, and also at Kanieri; they occur in Mount Greenland, near Ross, and probably form certain beds on Mount Rangitoto, although considerably altered there. They once more make their appearance inland of Okarito, forming the range lying due east of Lake Mapourika, where a most curious and striking resemblance may be seen between certain beds of syenitic character which occur there and other and similar ones which are cut in the North Star prospecting tunnel, at Reefton.

The slates, sandstones, etc., of the series, also appear in the Moonlight Ranges, striking through to Black Ball Creek.

All the beds hitherto mentioned are lying to the westward of the granitic belt, with the exception of those at Mount Rangitoto, where they are lying on the granite, which penetrates them as dykes and bosses. At Reefton they mantle over the older fossiliferous beds, upon which they lie unconformably. As a general rule, the dip of these beds is westerly, but, when they cover any extent of country, several anticlinal and synclinal folds occur.

They have been classified heretofore as the "Auriferous Series," and described separately from the beds which occur to the eastward of the metamorphic rocks, and which I am now about to mention.

These beds, which are known as the Maitai series, consist in their lower beds of blue silky slates, which strongly resemble the auriferous slates in character, although in colour they differ from them. They form a large part of the Taipo Ranges, where they lie, to all appearance, unconformably upon the foliated schists. They strike through at the head of Browning's Pass, and form the higher portions of the main range until reaching Mount Cook, the summit of which is composed of them, as is evidenced by the morainic *débris* of the glaciers, which consists chiefly of these rocks. Dr. Haast, in his report on Mount Cook, 3rd April, 1870, points out the same thing with regard to the Mueller and Tasman Glaciers, on the eastern side of this stupendous range.

South of Mount Cook, they seem to strike farther inland, as we see no signs of them in any of the river beds from the Karangarua south, the metamorphic rocks which form the western flanks of Mount Cook only appearing. It is in these slates, which, as before stated, form the lowest beds of the Maitai series, that the auriferous reefs of the Taipo have been discovered, and this, added to the similarity in mineral character between them and the so-called auriferous series, would seem to correlate them as one and the. same.

It is much to be regretted that no fossils have as yet been discovered in these beds, so that, for the present, absolutely conclusive evidence as to their comparative age is wanting, and we are compelled to rely upon the somewhat untrustworthy *datâ* furnished by lithological character.

The next beds, as regards age, which appear are the coal measures. These are found in the vicinity of Reefton, lying at comparatively low angles upon the denuded and upturned edges of both the auriferous slates and the older fossiliferous beds. They form Coal Hill, which is lying to the N.E. of Reefton, and they also cap most of the hills in the district. They occur again in Rainy Creek, lying at a high angle in the creek bed, and also moderately flat upon the ranges. They again make their appearance at Black Ball Creek, from which point they appear to strike away to the Brunner Mine, capping the slate ranges, and also descending to moderately low levels. They once more appear near Lake Kanieri, where, however, they are lying at a high angle, and, after leaving there, they are not again seen until reaching the country between Bruce Bay and Arnott Point, where they cover a moderate extent of country; but, up to the present time, no seams of any value have been discovered. They are overlaid at this point by beds of green sands, marls, limestones, and sandstones. The limestones, at parts, pass into a quality sufficiently fine for lithographic purposes, and a quarry is at present being opened up in these beds by Messrs. Arthur and Docherty.

At a short distance inland these beds are lying at a moderately low angle, but upon the sea-board they are frequently standing almost vertical, and are associated with certain volcanic rocks which occur in considerable mass at the Paringa, and, to all appearances, interbedded with the other rocks. The relations of these are, however, very difficult to make out, as also are certain conglomerate limestones which occur overlying them, in all probability unconformably; but I shall, in the detailed description of these rocks, endeavour to make their relations as clear as possible.

This patch of the coal measures and overlying beds are lying unconformably upon a tongue of mica schists which run down from Lake Paringa towards the sea, and they are once more seen at Jackson's Bay *(vide* special report on the coal beds of that district).

The next beds which come under our notice are those of the Kanieri series. They consist of green sands, marls, quartzose sands, and conglomerates, and they form an important feature in the country under examination. They commence at Reefton, forming the saddle between the Inangahua and the Little Grey, and from there they gradually widen out down the course of the Grey Valley, until, at the Ahaura, they cover a tract of country at least fifteen miles in width. After passing this point, they are gradually cut off by the older rocks, which approach more nearly to the sea as we go towards Hokitika, and at Ross we see the last of them, save for the occurrence of a small patch on the southern side of the Waikupakupa River. In the higher portions of these beds some of the principal alluvial workings have been carried on, and I shall have something to say about these in the sequel.

At and near Reefton the higher beds of the series appear; they also show in patches near Hokitika and Ross, and are once more seen at the Waikupakupa. As a rule, however, only the lower beds of the series appear in the vicinity of Hokitika, some point about there appearing to have been the centre of elevation.

They are overlaid unconformably by the glacier drifts, which extend north for some distance past Lake Brunner, angular fragments occurring capping the conglomerate hills up the Twelve-Mile Creek above No-town. They also show to a considerable extent near Bell Hill, and extend as far as the Ahaura. At Pounamu they occur in great mass, overlying the marls (blue reef of miners) of the Kanieri series, and they can also be well seen along the Waimea Water Race. From the Teramakau south, they completely smother all the other rocks of the district, and they form all the bluffs from Hokitika until reaching Bruce Bay, with the exception of the one south of the Waikupakupa, where the conglomerates of the Kanieri series appear, overlaid, however, by these drifts.

South of Bruce Bay, glacial action is not so apparent, although, at the Lake Paringa, and also in the low valley between the lake and the Abbey Rocks, evidences of the former presence of ice are seen.

The recent river shingles do not require any special notice here. They consist of broad shingle beds, extending sometimes as much as twenty miles inland before the rivers gorge.

The rivers, as a general rule, rise from glaciers, or, at any rate, owe the greater part of their water to the snow from the main range. They are liable to heavy floods, during which they frequently shift their channels.

The black sand beaches, which have in earlier days been extensively worked for gold, and are even now yielding a little, have been entirely derived from the metamorphic rocks forming the main range. They extend along the coast from Hokitika to Bruce Bay, and also, I believe, north of that point, although I did not examine the district between there and Greymouth.

I have now given a general description of the extent of the various formations, and a reference to the maps and sections accompanying this report will serve further to elucidate the general formation of the country. I have distinguished each of these formations on the map, and in cases (as in the Kanieri series) have further subdivided them, but, as a general rule, I have reserved the subdivisions for the sections, the scale of the maps not being sufficiently large to admit of small patches of any formation being shown on them with any degree of distinctness.

I have purposely avoided in this report any allusion to the absolute age, geologically speaking, of the various beds, as this can only be settled by a comparison of the fossils from these and other beds, and should, I conceive, form the matter more of general examination than of special report on any one district.

To turn now to a description of the various beds separately, commencing from the lowest and working upwards, the first beds under consideration are—

Granite and Granitic Gneiss.

Having previously specified the extent of this formation, there is no need to make any further mention of it, and I shall simply confine myself to a description of the various points of interest connected with it.

It is, in places, of a truly intrusive character; at others, again, it it exhibits marked lines of apparent stratification; but, from the close connection with those which are truly intrusive, it is impossible to separate them one from the other without very careful and prolonged examination.

Mount Rangitoto exhibits the most striking instance of their intrusive character. Here there are certain beds of slates, sandstones, and micaceous schists, in which lodes occur, and these beds are penetrated in various places by dykes and bosses of granite, which rise to the summit of the hill (an elevation of between 3,000 and 4,000 feet), and penetrate the strata without affecting the dip of the beds.

At Granite Hill, again, the granites are intrusive, for here we get mica schists lying away to the westward of the granite, as well as on the east side of it. Dr. von Haast describes a hill about a mile to the west of the Alexander stream, which empties into the River Grey, as being composed of a porphyritic granite of truly intrusive origin.

On the other hand, in Mount Turiwhati and Island Hill, apparent bedding is seen, the strike of the beds being N. 20° E., and the dip S.S.E., at an angle of 40°. The block of hills on the north side of Teremakau, of which Mount French and Mount Smart are the highest peaks, exhibits signs of stratification in parts, but the rocks generally are of a truly granitic character, and Hunt's Hill, on the north side of Paringa, is also, to all appearance, of intrusive origin. Taking all the foregoing observations into consideration, I have decided to group together those granites which are truly intrusive, with those which appear to exhibit lines of bedding, leaving their subdivision for some future time.

Metamorphic Rocks.

The lowest beds of this series are gneissic in character. They appear in the conical hill at the foot of the Fox Glacier, and also strike through the base of the ranges to the north and south of this point, their strike being N.N.E., and dip E.S.E., at an angle of 70°, and they appear again further north, forming the flanks of the ranges from Ralph's Knob to the Wataroha River. The stratification of these beds is so thoroughly distinctive as to entirely separate them from the granites previously mentioned. The section of the beds may be well seen in the ranges by the Fox Glacier. As mentioned above, the lowest beds of the series are a true gneiss; farther inland, across the strike of the beds, mica schists appear, passage beds or alternations of gneiss and mica schists occurring between them and the gneiss proper. A great thickness of mica schists appear, and they pass gradually into chlorite schists; or, rather, frequent alternations of micaceous and chloritic schists occur in the section.

In these chlorite schists large quantities of magnetic iron are found disseminated through the bed rock in the form of minute crystals, which at places have become so plentiful as to form beds, interstratified with the schists, from 6 inches to 8 inches in thickness, and it is doubtless from these rocks that the magnetic sands of the beaches have originally come.* Mr. Skey has assayed a specimen of this magnetic iron for gold, and informs me that there is not the slightest trace to be found, neither is titanium present; therefore, in all probability the crystals are not of volcanic origin. Crystals of iron pyrites also occur more or less plentifully scattered through the chlorite schists, crystallizing, as a general rule, in the form of cubes.

The highest beds of the series are quartzites, which, however, we failed to reach, nor did we see the overlying Maitai slates in this section. The strike varies from N.N.E. to N., and the beds dip uniformly in an easterly direction, at angles varying from 70° to almost vertical, and it is probable that several sharp anticlinal and synclinal folds occur.

The glaciers bring down immense quantities of the Maitai slates and sandstones—in fact, the terminal moraines are composed almost exclusively of these rocks, the lateral ones, however, being much mixed with the metamorphic rocks just described. This clearly points to the fact that the higher parts of the main range are composed of these rocks, and, more especially, that at Mount Cook they occur in considerable quantities.

South of Mount Cook the metamorphic rocks form a still more important feature in the formation of the country, to the exclusion, from the Karangarua south, of all other beds. In the lowest beds of the mica schists, veins of white quartz appear, with which are associated various minerals, such as galena, copper pyrites, and iron pyrites, which latter, in its first stage of decomposition, exhibits a softness that is very deceptive. A variety of actinolite, also frequently much decomposed, occurs associated with these beds, in radiating fanshaped crystals. These minerals may be seen in most of the river beds, more notably in the Paringa, Weheka, Wataroha, and Waitaha, where they are very plentiful.

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* Hacket, Geol. Rep., 1869, p. 12.

Along the Christchurch Road a good section of the metamorphic rocks is seen, although they appear over a considerably less width of country there than farther south. They vary in strike from N. 10° E. to N. 10° W., and dip to the eastward at from 50° to 75°. They consist, as before, of alternations of micaceous and chloritic schist, and appear to die out at or about the 35th mile post, being overlaid there unconformably by the Maitai slates, to be hereafter described.

North of this point, very little is seen of them in the district under consideration, and I shall accordingly leave them now, and proceed to describe the

Older Fossiliferous Rocks occurring in the vicinity of Reefton.

These beds are well seen in Lanky's Gully, the *débris* of the creek being chiefly composed of them. Going up the creek, red coloured cherts with fossils, which form the lowest beds of the series, are first seen; then certain blue and grey limestones, with large *Madrepore* corals, appear; and farther on still, black slates and shales, which are radically different in mineral character from the auriferous slates, and which contain large numbers of *Spirifer*, etc., crop up. Where first seen these beds are striking N. 10° W., and dipping E. 10° N., at a high angle, but to the eastward this dip changes to S. 80° W. The point of junction between these beds and the auriferous slates is near here, and whereas the cherts, etc., are striking N. 10° W., and dipping E. 10° N., the auriferous rocks are striking N.E., and dipping to the westward—pointing strongly to an unconformity which probably exists, although the absolute line of junction cannot be seen. East of this point, again, the cherts appear in great mass, forming, in fact, the hills on the eastern side of Lanky's Gully.

At Cement Town the cherts again crop out, having been obscured between Lanky's Gully and here by the coal beds which cap the hill. At this point they are striking N. and S., and dipping E., but the dip changes a short distance down Murray Creek to the westward, and they are then overlaid by the auriferous slates in a manner which renders it difficult to say whether conformably or otherwise.

In Rainy Creek they once more appear. The first beds seen in ascending the creek, after passing the auriferous slates, are the cherts, which are striking N. and S., and dipping E., at an angle of 60°.

They are well exposed in a cutting for the road to the Rainy Creek quartz mine, and the cherts are here underlaid by beds of a crystalline limestone, and below these again fossiliferous slates, in which large numbers of *Spirifer* occur, are seen. In these slates we also found portions of two large *Trilobites*. After passing this point the dip changes to the westward, and a repetition of the beds occurs, the auriferous series coming in beyond.

It will be remarked that here the cherts are the highest beds of the series, and the slates the lowest, whereas in Lanky's Gully the reverse is the case. Alternations of these beds then occur, those in Rainy Creek being the higher beds of the series.

It is here again impossible to say whether these beds are overlaid conformably or otherwise by the auriferous rocks; but, from the evidence gathered in Lanky's Gully, I think there can be little doubt that unconformity does exist.

The fossiliferous beds occur over but a comparatively small area, rising as a boss through the auriferous series. At a short distance on each side of the point of junction between them and the auriferous slates in Lanky's Gully, they differ radically from them both in strike and dip. In Murray Creek the auriferous slates rest upon the older cherts; in Lanky Gully, upon the *Spirifer* slates; and in Rainy Creek, upon the upper cherts, so that the evidence is strongly in favour of unconformity existing.

The Auriferous Series.

These rocks, as their name implies, are the gold-bearing rocks of he district. At Reefton they form an important feature in the ormation of the country, that being the point of their greatest development. They consist, in their lower beds, of frequent alternations of sandstones and slates, more or less tufaceous in parts. Higher n the series they pass into slates; then a slate breccia appears; then late again; and, lastly, a finely laminated clay slate, a good section of hese rocks being seen in Murray Creek.

Where the slates are first seen on leaving Reefton, they dip W.N.W., at an angle of 60°. About 20 yards further up the creek, it changes to E.S.E., at the same angle. Alternations of sandstones then come in, and then green whet slate. The dip changes twice more before reaching Cement Town, pointing to the existence of two anticlines, with axes striking about N.N.E.

In Soldier's Gully these rocks occur striking nearly due N. and S., their general dip appearing to be westerly, at a high angle, and here also the slate breccia is seen interbedded with the slates.

Up the Mangahua a similar section is seen to that which appears in Murray Creek; the beds, however, strike more in a N. and S. direction, the dip changing, as before, from E. to W. as the anticlines are passed.

The North Star prospecting tunnel has been driven through slates for some distance, but a dyke, or what appears to be a dyke, of an intrusive crystalline rock of very considerable thickness has been cut, and the drive is barely yet through it.

At the mouth of Rainy Creek, where it empties into the Inangahua, the auriferous rocks are striking N. and S., and dipping east. Further up the creek, as before mentioned, the fossiliferous rocks come in, and after passing these the auriferous slates once more make their appearance, dipping away to the westward at an angle of 50°. This series prevails, forming the ranges between Rainy Creek and Antony's Flat, and extends down from there towards the Grey River, covering, however, a far less extent of country here than in the Reefton district.

Several reefs have been struck in these beds, all, with one exception, following the same line of strike, viz., a little to the west of north, which carries them through from Rainy Creek to the Wealth of Nations Claim and the claims lying to the north of this point. I shall have to mention the reefs again further on, so I will say no more about them at present.

This formation again appears between German Gully and the Black Ball Creek, and again on the western bank of Black Ball, where it is capped by the coal measures. It also forms the principal part of the Paparoa Range, at this point striking W. 30° N., and dipping S. 30° W., at an angle of 60°. At Bell Hill they again appear, striking N.E., and dipping S.E., at an angle of 45°.

On the south-west side of the Kanieri Lake, the auriferous rocks also occur, and probably occupy the area shown on the maps. They are, however, so obscured by glacial drift as to render it a matter of extreme difficulty to trace their extent, or even to see them *in situ* at all. They appear again in Mount Greenland, of which they form the bulk, and where they strike about N.W., and dip N.E., at an angle of 70°. They can be traced in all the gullies up the Mikonui as far as the Gorge, after passing through which they are cut off by the granite which occurs in Mount Rangitoto and rises to form Frazer Peak.

On Mount Rangitoto certain beds appear, which I believe to belong to the auriferous series. This is, however, open to question. They consist of sandstones and slates, which are more or less micaceous, and which are highly metamorphosed in parts. They strongly resemble certain of the mica schists, and as such I was at first disposed to regard them; their position, however, added to their strong resemblance at times to the auriferous rocks, leads me to class them with that series. The strike of the beds is W.S.W., and the dip N.N.W., the angle varying from 30° to almost vertical. Altogether, they appear to be much contorted and changed, and they are traversed by lodes and quartz reefs, and also by dykes and bosses of granite, which I have previously mentioned.

The last locality at which these beds occur is to the east of Lake Mapourika. About two miles along the road from the forks, towards the lake, an outcrop is seen. Here they consist of bands of slate much shattered, and interstratified with a syenitic rock which exhibits a striking resemblance to that seen in the North Star prospecting tunnel, at Reefton. They strike N.N.E., and dip E.S.E., at an angle of 40°.

The stratification of these beds is unmistakable at this point, but, were it not so marked, I should certainly pronounce the syenitic rock as intrusive in character. Under the circumstances, however, it seems doubtful whether even that which occurs at Reefton is not interbedded with the other rocks of the district.

In McDonald's Creek, which empties itself into Lake Mapourika, the auriferous slates again appear, striking N.N.W., and dipping W.S.W. A syncline therefore exists between these two points, the slates lying unconformably upon the denuded and upturned edges of the metamorphic rocks. In McDonald's Creek a quartz reef has been found, but its auriferous character has not as yet been proved.

The Maitai Series.

These beds, as before mentioned, I believe to be the equivalents of the auriferous series, and are only seen *in sitû* in the district which I have been over, in the Taipo Ranges. At a short distance on each side of the point of junction between them and the metamorphic rocks, the strike of the two differs by about 30°—that of the Maitai slates being N. 40° E., and dip S.E., at an angle of 70°; the strike of the mica schists being N. 10° E., and dip S.S.E., at an angle of 75°. The Maitai slates thus overlie the metamorphic rocks unconformably. They strongly resemble the auriferous slates in their lower beds, and the Maitai sandstone is, in all its characters, identical with that of the auriferous series. With the exception of what appears to be a coral, and also some tubes which have been put down as *Dentalium*, no sign of fossils could be seen in any of these beds, and their absolute age therefore still remains unsettled. They occur over a great tract of country from this point, but my present work, as far as they are concerned, terminates close to their junction with the metamorphic rocks. In their lower beds, and close to this junction, the reefs of the Taipo occur, which I shall mention anon.

The Coal Series.

The most important coal deposits which I have seen during this trip are those which occur in the vicinity of Reefton, and in Coal Hill, a table-topped mountain which rises about 500 feet above Reefton, where on the north-east side of the town, they appear to assume their greatest dimensions.

This hill is composed exclusively of the coal measures, and a mine is in process of being opened up by the Reefton Coal Mining Company. The outcrop, which is being worked, occurs on the far side of the hill from the town, at an elevation of 250 feet, and a tramway is being carried over the hill for the transport of the coal. At the outcrop, the strike of the coal is N. 10° E., and the dip W. 10° N., at an angle of 22°; but at a very short distance to the south-west of this point the dip is much less, the overlying micaceous clays dipping W., at an angle of 10°. From the outcrop a line has been cut due north, and coal appears along this line where it crosses two creeks in succession.

In the second of these creeks the overlying micaceous clays are seen, and also coarse quartz grits, which underlie the coal. In the drive a band of fireclay occurs, about 3 feet thick, underlying the main seam of coal, which is about 21 feet thick; below this fireclay; again another seam of coal, 3 feet in thickness, appears.

In the cutting for the tramway, from the outcrop of the coal to the summit of the hill, the following section of beds is seen:—

Black micaceous sandstone.
Grits.
Sandstone.
Grits.
Micaceous clays.
Coal, 21 feet.
Fireclay, 3 feet.
Coal, 3 feet.

Taking the average strike and dip of these beds, the coal may be said to be striking N. and S., and dipping W., at an angle of 10°.

On the Reefton side of the hill, coal has also been worked, at a lower level than that of the Reefton Coal Company, by about 80 feet. This coal is much crushed and mixed with extraneous matter. It evidences in every way that it is only slip coal, and I have no doubt that the main seam will be struck higher up the hill, probably dipping away to the eastward. The amount of slope deposits, however, renders prospecting almost hopeless, without either cutting trenches or boring.

From the head of Lanky's Gully over to Cement Town, the coal beds also appear, and where first seen they consist of cement beds lying upon the shales of the coal series. These so-called cement beds, which consist principally of water-worn quartz pebbles in a consolidated condition, are overlaid at places by quartz grits, proving, beyond a doubt, that they are truly of the age of the coal, which they appear to overlie.

At Cement Town a good seam of coal is being worked by the Energetic Company, for the supply of their boiler. It is overlying certain cherts, which are well seen on the track to the Westland Crushing Machine. These cherts differ in appearance from the older ones previously mentioned, but, at the same time, their relation to the coal is difficult to ascertain. I am inclined to believe that they truly belong to the series, although their mineralogical character, and the fact that they are traversed extensively by then veins of quartz, would seem to point to their greater age.

In Soldier's Gully, on the left-hand branch of the Inangahua, several small seams of coal are seen, all occurring at a moderately low level, and dipping at an angle of 45° to the west. Judging from their high angle and position, I do not think any great extent of coal can be looked for here. Bands of lignite also occur in the neighbourhood, but, as I shall presently show, associated with much younger beds.

In the vicinity of the Rainy Creek township, coal rocks appear, striking N.E., and dipping S.E., at an angle of 55°, and it is noticeable that here, as at most other places, all coal rocks which are seen in the gullies are lying at a high angle, those on the summits of the ranges assuming a more horizontal position.

Mr. McKay reports that on the north side of Rainy Creek coal measures occur capping the hills, in tabular masses, striking S. 75° W., and dipping N. 15° W., at an angle of 6°, or lying almost horizontal. These beds I did not see, but found that the coal measures capped the hills between Rainy and Marigy Creeks.

At Black Ball Creek, coal has again been discovered. It is found cropping out in the first left-hand branch, which is now known as Coal Creek. The coal measures strike east and west, and dip south, at an angle of 10°, the seam of coal which is seen close to the bed of the creek being about 3 feet thick. This lies upon a parting of shale, which is again followed by coal, which holds to the bottom of the creek, and probably deeper, so that its true thickness cannot be determined.

Now, with regard to the coal series occurring south of Bruce Bay, the extent of which will be seen on reference to the map. In the neighbourhood of the Abbey Rocks the coal grits appear, dipping to the westward at an angle of 45°, and lying unconformably upon a tongue of the mica schists, which are exposed in the creeks. No coal occurs associated with the grits on the west side of the mica schists; they are overlaid by marls, sandstones, and limestones, from which the lithographic stone is derived. To the eastward of the mica schists the coal measures again appear, and good sections of them can be seen in the creeks. They are lying here at a much lower angle, striking from S.W. to N.W., and dipping N.W. to N.E., at angles varying from 15° to 20°. They come down to the level of the sea, and are exposed in high cliffs, over which water falls in magnificent cascades.

The lowest beds exposed are the coarse quartz grits, above which alternating bands of blaze and grits appear, with thin seams of coal perhaps 8 inches thick. These are overlaid again by a black micaceous sandstone with numerous fern impressions; then sandstone appears, capped by cement beds, and from the summit of these beds to the top of the hill sandstones prevail.

These coal rocks are doubtless identical with those of the Brunner Mine, but whether coal occurs in any quantity or not it is at present impossible to say. So far, no seam of importance has been struck, 60 inches to 88 inches being the greatest thickness seen; but the coal measures occur in considerable mass, and they have by no means been thoroughly prospected, neither is it shown whether or not the thin seams which appear at the outcrop thicken out further into the hill. Should the lithographic stone quarry prove a success, it would be a matter of the greatest importance to find coal in the district if possible, as it would greatly enhance the value of the property, and form an additional inducement for vessels to trade to the port, and thus greatly reduce the freight which would at present have to be paid for the transport of the slabs of lithographic stone.

Upper Beds of Coal Series.

Overlying the grits, etc., of the coal measures in the neighbourhood of the Abbey Rocks, other beds appear, which present some very considerable difficulties in determining their mode of association with certain volcanic rocks of the district, and also as to the relation which certain overlying conglomerate beds (which appear to point to an unconformity existing at some point in the series) bear to them. The thorough elucidation of the above questions, I do not pretend to have accomplished, and can only place observed facts upon paper, leaving a more complete settlement of their relations for some future time.

Perhaps the best section of these beds which can be seen is that which occurs from where Mr. Docherty has begun to open a quarry in a blue limestone, to the top of the hill. Here all the beds are well exposed, as follows:—Overlying the coal grits, beds of tufa and a fine-grained brecciated volcanic bed appear, exhibiting a regular stratified character. They are overlaid by marls, and then a band of blue limestone comes in, which, when I arrived at the Abbey Rocks, Mr. Docherty was opening up to prove its quality as a lithographic stone. This limestone is well backed, but is not traversed to any extent by veins of calcspar. It is, however, quite distinct from the limestone boulders in the creek.

These beds are striking N.E., and dipping N.W., at an angle of 45°; but, as we ascended the hill, the beds, although still dipping to the N.W., were found to be lying at a lesser angle, pointing to the occurrence of a syncline at or near this point.

Overlying the limestone, black shales appear; then green sands and a grey sandstone; then alternations of marls and shales appear again; and then, near the summit of the hill, we came into another limestone zone, the lower beds of which are coarse, and similar to certain limestones which occur on the coast line, and which will be hereafter mentioned. As we ascended, the limestone gradually improved in character, being first of all traversed by veins of calcspar, then these veins disappear or become more scarce, occurring only in sufficient quantities to form good backs to the stone, and render it moderately easily worked. The stone itself here assumes the fine-grained character of the boulders in the creeks, and it is undoubtedly from this horizon that the slabs which have been tested have come. Before reaching the top of the hill the limestone becomes somewhat coarser once more, and the hill is eventually capped by a fine-grained quartz sandstone, which forms a small patch on its summit. This band of lithographic stone may be traced for some distance to the southward along the face of the hill, and, on coming to the sea face, the beds are well exposed in scarps. They strike N.E., and dip N.W., at an angle of 15°.

The band of limestone, which, as before mentioned, varies considerably in quality throughout, is at least 150 feet in thickness, nearly the highest beds being the finest grained in quality.

South of the Abbey Rocks, limestone occurs on the sea coast, striking E. and W., and dipping N., at an angle of 50°; but, at a short distance south of this, it changes again to a N.E. strike. Marls then appear below the limestone, and then green sands, in which fossils, *Panopæa*, etc., were found, but very indistinct, as general rule.

In the first creek south of the Abbey Rocks, volcanic rocks again appear, but this time immediately underlying the green sands, which brings them higher in the series than those previously mentioned.

To the north of the Abbey Rocks, along the coast line, marls first appear, and form the headlands for some distance along the coast, striking N.E., and dipping N.W., an an angle of 55°. Further north, limestones and sandy marls interstratified appear, the limestone being of a texture similar to the lithographic stone, but much broken, and traversed by dark-coloured veins, the whole forming a stone which, when polished, would make very handsome flags. This limestone is overlaid again by marls, and then conglomerates appear, and at the point where these beds come in a sharp anticline is seen. It is probable that at this point an unconformity occurs. The dip changes on passing this anticline from N.W. 80° to N.W. 50°, and a sequence of rocks, which consist of a frequent repetition of coarse sandstones and conglomerates, occurs running out to the Piakatu Point.

At the mouth of the Paringa River, a band of limestone, traversed in all directions by veins of calcspar, occurs, and this may be traced throughout from here to where the impure marble occurring on Messrs. Arthur and Docherty's lease is seen. At the mouth of the Paringa it is striking N.E., and dipping N.W., at an angle of 65°. It rests upon the volcanic rocks, which here occur in great mass, forming, by far, the most prominent feature of the country. It is overlaid, to all appearance conformably, by marls, and then by the alternations of coarse sandstones and conglomerates mentioned as occurring at the Piakatu Point.

On the north side of the Paringa River, we see no signs of the lower beds of the series, the coast line consisting of a coarse conglomerate containing large boulders of the lithographic stone, and also considerable quantities of the volcanic rock above mentioned. Inland the beds belong to the coal measures, so that the strata in which the lithographic stone occurs appear to be confined to the vicinity of the Abbey Rocks.

Now comes the question of the age of the volcanic beds which occur here, and this I do not think I have sufficient *data* to settle. They occur overlying the coal grits, and in direct sequence with the beds overlying them; they occur immediately below the greensands, and again immediately below the broken limestone of the Paringa River, so that all that can be said is, that they are certainly of less age than the coal grits. It seems probable, from their different relative positions at different places, that surface flows must have taken place at distinct intervals, but where the centre of ejectment was, or what was the cause of their comparatively small distribution, the evidence at present is not sufficient to determine.

Again, with reference to the apparent unconformity. A perfect succession of beds is traced from the coal grits to the summit of the hill, or the fine-grained sandstone capping the lithographic stone, so that no unconformity can take place in that series. Then comes the question of correlating these beds with those which occur on the sea coast, and which are lying at a much higher angle than the ones further inland. This, from the constant repetition of the beds, is not an easy matter; but, taking the green sands as an horizon, it would appear that the limestones of the south side of the Abbey Rocks are contemporaneous with certain of the limestones of the lithographic series. Now, turning to the conglomerates, etc., which overlie these beds from Piakatu Point north, we find that throughout they contain boulders of lithographic stone, and that north of the Paringa they are composed principally of boulders of this stone, which would necessarily point to a high unconformity. On the other hand, the inland or older beds are lying at a comparatively low angle, while those on the sea-board, which, it is true, are associated with the volcanic rocks of the district, are at times standing nearly vertical, and exhibit contortions which, in beds of their age, are exceedingly curious and puzzling to account for.

The Kanieri Series.

These beds cover a very considerable area—from Reefton as far south as Ross—and they appear once more as an outlying patch at Waikupakupa. They consist of the following sequence of rocks :—

d. Conglomerates.
b. Loose brown sandstone.
j. Shell limestones (interstratified with *b*).
g. Blue marls (blue reef of diggers).
e. Green sands.

The green sands, which form the lowest beds of the series, are only seen at Callaghan's Creek, near Goldsborough, where they are well exposed in the cuttings of a tail race, and from these beds a large number of fossils—*Pecten*, *Cucullæa*, *Natica*, etc.—may be obtained. They are very dark in colour, at places being almost black, and are dipping N.W., at a low angle—in fact, lying almost horizontal.

These are overlaid quite conformably by marls, in which shells also occur, but the nature of the matrix does not favour their preservation. There are, however, certain calcareous concretions in these beds in which the shells are well preserved. These marls occur to a thickness of 200 feet or 300 feet at this point, the higher beds of the series being absent; but a very good section of the beds can be seen along the Waimea Water Race, from the head of the pipe section down.

Directly on leaving the pipe section, a small patch of the conglomerates, which are the highest beds of the series, are seen, the glacial "till" lying unconformably upon and filling hollows in them. These conglomerate beds appear through the two first tunnels, dipping east at an angle of 12°, and, passing on, they change to a blue sandy marl weathering brown; then a band of quartz sands, about 3 feet thick, appears, passing with various alternations of the above beds into the blue marls with fossils. In this passage the dip of the beds is gradually becoming more slight, until, upon reaching the neighbourhood of Red Jack's, they are lying horizontal, and from these they take a slight westerly dip towards the sea. On the Kanieri Lake track the marls also appear, and they form the base of the Blue Spur, near Hokitika. At Ross, again the marls make their appearance, having, in their higher beds, layers of shell limestone interstratified with them, and it is noticeable that in these beds *Cucullæa* appears to have died out—at least we could not find any in them. They are overlaid by the brown sands and conglomerates, the whole dipping N.N.W., at an angle of 30°. Gold workings have been carried on at Ross, both in the conglomerates, and also in the "till" which overlies the whole formation.

Passing north from Callaghan's, we find the marls occurring in great mass at the Greenstone, capped by the brown sands, and these extend up to No-town, being there exposed only in the beds of the creeks, the conglomerates coming in and capping them. From this point, until reaching Reefton, we do not again see the "blue reef," but only the conglomerates and underlying brown sands, which form the bottom of the gold workings of this formation in the northern district.

The Kanieri series covers an extent of country in the neighbourhood of the Ahaura, at least 15 miles in width, and they extend uninterruptedly to Reefton, forming the saddle between the Inangahua and Grey Rivers. They rise frequently to an elevation of 500 feet to 600 feet, forming a most broken country, consisting of deep gullies with vertical sides rising to the summits of the hills. They narrow considerably in the vicinity of Reefton, where they dip S. 80° W., at an angle of 10°, a band of quartz grits appearing interbedded with the brown sands, with which also thin bands of lignite occur. Further north they widen out again, to form the Port Hill conglomerates of Nelson.

It is noticeable that at Callaghan's, and also for a short distance north and south of this point, that the marls and lower beds generally of this series appear at the surface, the overlying conglomerate beds being totally absent; whereas, further north and south, the higher beds appear. From this it seems probable that some point in this neighbourhood has been the centre of elevation when these beds were raised above the level of the sea.

The Glacial Drifts.

These beds, which occur over an immense area of country, are the most recent seen. They are found capping, and to a great extent obscuring, all other beds from the Ahaura as far south as the Mahitahi River, and also show signs, on a smaller scale, of the former existence of ice still further south than that. They occur largely in a district radiating from Mount Cook, and form all the bluffs from the Mahitahi north, having evidently in former times been the lateral moraines of glaciers which have long since retreated, the only remains of which are now seen as the glaciers of the present day, which, however, descend to a most unusually low level for a temperate climate. The Fox Glacier, which is the lowest of any, reaches an elevation of not more than 670 feet above the level of the sea.

The morainic *débris* along the coast is composed chiefly of the Maitai and auriferous slates and sandstones, mixed, however, with the metamorphic rocks, which are more plentiful the further we go south, and some blocks of which could not weigh less than

10,000 tons. Angular pieces of the volcanic rock occurring at the Paringa are also associated with the morainic matter in the bluffs, gradually disappearing as we pass to the northward, which points to the fact that during the period of the greatest extension of the glaciers the great centre of elevation was from a point south of Mount Cook.

At the head of the Waimea Water Race, from where it crosses the Christchurch Road to the dam between Mount Turiwhati and the Island Hill, the beds consist of a true "till," not a single rounded stone appearing throughout; whereas from that point towards the sea, although angular stones are more frequently seen than any others, still rounded and water-worn stones also appear in very considerable quantities, and would give one the impression that the glaciers of former times descended to a shallow sea, which extended over the greater part of the country now composed of the Kanieri series and overlying glacial drifts. This is not, however, necessarily true, as advances and recessions of the ice must have taken place here as elsewhere during the glacial epoch, and a striking instance of such being the case may be seen on the Christchurch Road shortly after crossing the Taipo River, and opposite the Big Paddock. Here there are marked evidences of the former extension of Lake Brunner, which must have been formed originally by the agency of ice, and then, as the ice receded, we get the shingle of the lake, which at this time covered what is now the Big Paddock, composed exclusively of the metamorphic rocks of the surrounding hills, and these are again overlaid by glacial drifts, consisting chiefly of the Maitai rocks, which are only found further inland. The recession of these glaciers would necessarily be attended by the formation of rivers flowing along the course formerly held by the ice, and this would account for the rounded stones. In these drifts extensive gold workings have also been carried on, which have to be mentioned under a separate head.

MINERAL RESOURCES OF WESTLAND.

We now come to a most interesting point to be considered, viz., What is the value, or possible value, of the various formations which I have above described? or, in other words, what is the value of the various beds, lodes, etc., at present known, and what are the prospects of the discovery of further deposits, either of a similar or different character? In the first instance let me mention the *Lithographic Stone* recently discovered by Messrs. Arthur and Docherty.

This stone, which occurs in the vicinity of the Abbey Rocks, is found over an extent of country reaching inland about three quarters of a mile. It occurs as beds of limestone, varying greatly in quality from the higher to the lower levels, the total thickness being not less than 150 feet. Some of this stone is of a fine-grained character, and answers excellently for plain black and white work, as is evidenced by such samples as I have seen of lithographs executed upon this stone, one of which is a photo-lithograph by Mr. A. McColl, of Melbourne.

Mr. Wilberg, the lithographer for the Provincial Survey Office, Hokitika, speaks very highly of its quality, stating that some of it is even superior to the German stone; but a careful examination shows *Foramenifera* excessively minute occurring throughout this stone, and it yet remains to be seen whether samples can be procured which are sufficiently homogeneous throughout to be employed in the finer work for which lithographic stone is used and for which crayon shading is employed.

Should stone of a quality suitable for this work be obtained, the discovery will doubtless be of the greatest value, and there will not be any difficulty in obtaining slabs of any size which may be required in lithography perfectly free from veins of calespar, etc. The position of the quarry is such as to give a good spoil heap, and no great difficulties will attend the formation of a tramway for the transport of the stone from higher to lower levels. The principal part of the stone of a quality at all suitable for lithographic purposes is enclosed by the lease taken up by Messrs. Arthur and Docherty, that to the north of it being so much traversed by veins of calcspar as to be practically valueless, so that, should the trials made of the stone be considered satisfactory by the speculators, there is little doubt of the success of the undertaking.

Silver Lode on Mount Rangitoto.

This lode, which is about 10 inches thick, crops out on the southern face of the mountain, above the left-hand branch of the Waitaha River. It dips N.N.W., at an angle of 30°, this dip corresponding with the dip of the strata, and also running under the hill. The prospectors informed me that it appeared to dip at a much higher angle at a short distance into the hill.

A face of about 35 feet has been exposed along the strike of the lode, showing the character to be uniform throughout, and to consist of pyrites, with about 20 per cent. of galena, a sample brought up by me from the mine yielding 1 oz. 17 dwt. of silver per ton of ore. It will be seen that if this is a fair sample of the lode, under the present condition it would be worthless, as neither the silver nor lead is in sufficient quantities to pay for working, more especially under the difficulties arising from the position of the mine, which is nearly 3000 feet above the level of the sea; but if the result of the assay at the Melbourne University, which was published in the papers, and which returns 735 oz. of silver per ton, be correct, then the ore varies very much throughout its course, and might prove to be of great value. Of this I cannot say anything, but can only treat of the present and possible value of the lode, taking the assays performed at the Museum Laboratory by Mr. Skey as my basis.

Mr. W. Wallace, in his admirable work on the lead veins of Alston Moor, gives four general rules governing the distribution of lead:—

(1.) That the quantity of water in circulation below the summit of the mountain is "in inverse proportion to the depth from the surface, and in direct proportion to the distance from the watershed." Therefore, the greater the depth, the less the quantity; the further from the watershed, the greater the quantity.

(2.) The steeper the mountain slope, the less the water under it; the smaller the inclination, the more the water.

(3.) The freeness of circulation of water near the surface is directly proportional to the amount of inclination of beds, faults, joints, or veins *towards* the side of the hill, and *vice versâ*.

(4.) The greater the number of veins, faults, intersecting large lodes, etc., the greater the circulation, especially when corresponding to the dip of the strata, and therefore the greater chance of the lode to which they run being ore bearing.

It must be understood in the foregoing rules that as the lead is supposed to be deposited from solution, that the greater the circulation of water, the greater the ore-bearing character of the lode.

Let us now see how these rules favour the Mount Rangitoto lode.

The lode being about one-third of the distance down the hill, and near to the watershed, is unfavourable by law 1. The slope is very steep, which is unfavourable by law 2. The dip is into the hill, at an angle of 30°, with the strata becoming more nearly vertical at a short distance, which is strongly favourable by law 3, and the whole of the beds are traversed by veins and dykes of granite, and leaders of quartz containing specimens of copper are also found, which is favourable by law 4.

Taken as a whole, the conditions appear to be favourable, and it is very probable that a good lode would be struck if the existing outcrop were driven upon, or rather if a drive were put in at a lower level to strike the lode at some distance into the hill; but the present outcrop is not of sufficient value to work on its own account.

Mr. Charles E. De Rance, F.G.S., in a paper read before the Geological Society in February, 1873, entitled, "Mineral Veins in the North-East Country," while acknowledging the truth of Mr. Wallace's rules, as applied to Alston Moor, comes to the conclusion that, unless we modify the present outline of the country in our considerations of its mineral character to what it must have been at the time of the formation of the lodes, the above rules are of little value, except in districts where they have been shown to apply; and he also points out that, in the country examined by him, "the quantity of ore is determined more by the nature of the matrix than by the distance from the watershed and from the surface."

If, however, Mr. Wallace's rules are applicable for the Mount Rangitoto district, the necessary modification of the surface of the country, according to Mr. De Rance, would only tend to render the conditions somewhat more favourable by law 2, as it would reduce the angle of the mountain slope, and, at the same time, would not change the conditions as regards laws 3 and 4, which are at present favourable.

I mentioned in an earlier part of this report that in most of the river beds minerals of various character—copper, lead, and pyrites—are found, but at present, if we except the lode in Mount Rangitoto, none of these have been found *in situ*. That they do occur associated with the metamorphic rocks, there is no doubt; but prospecting for them would necessarily be a matter of time, and is outside my province, under existing circumstances. All I can say is, that such minerals doubtless exist, and, as far as I could make out, they appear to be associated with the lower beds of the mica schists.

With regard to the magnetic iron occurring with the chloritic schists, from which the magnetic sands of the coast are derived. This has been carefully assayed for gold by Mr. Skey, none, however, existing, so that their value is nil, as they do not occur in sufficient quantities to be worked as an iron ore.

Clay ironstone occurs associated with the coal measures of the

Paringa district. I did not see any bands of it, but only found it as boulders in the creek, sometimes, however, of considerable size.

I have, in the description of the coal measures, said all that is necessary on the subject of coal, and have now only to say a few words in conclusion on the gold, in doing which I shall subdivide the workings as follows :—

1. Reefs.
2. Cement workings.
3. Alluvial workings.
    - *l.* Workings on slate bottom.
    - *b.* Workings in conglomerate formation, principally upon brown sandstone bottom, but also on false bottoms at Ross, etc.
    - *j.* Workings in glacial drift.
    - *g.* Workings in black sand beaches.

The reefs which are being worked to the best advantage are those of the Inangahua, in the vicinity of Reefton, where they occur is a formation which I have described as the auriferous series. The general strike of the reefs is a little to the west of north, not differing greatly from that of the beds themselves. To take the Wealth of Nations for an example. This mine is situate on the southern side of the spur which forms the left-hand bank of Murray Creek, and is on the same line of reef as the Energetic Company, whose lease is on the other side of the spur. The strike of this reef is in a direct line with that which has been found at Rainy Creek, and which is now being opened up. In the main workings of the Wealth of Nations the reef has widened out to a considerable size, and has proved uniformly good throughout. A second reef has lately been struck here, striking S. 10° E., and dipping E 10° N. This reef has been sunk on with an inclined shaft to a depth of 60 feet, where it becomes vertical, and eventually takes a trend to the westward. If, then, the other lodes be taken as the true lodes of the district, this is a counter lode. I am informed that, as a rule, the reefs of this district do better when standing in a more or less vertical position, the flatter ones being generally the poorer; but how far this may be taken as a rule I am unable to say, as no record of mining operations appears to have been kept, and one has consequently only to go upon hearsay for any information gained. I believe that by keeping a record of all mining operations, returns of crushings, strikes, dips, and power of the lodes, at different points, some very valuable information might be obtained, and *data* more or less reliable compiled for reference. Up to the present time no signs of the reef have been seen in the older fossiliferous beds, but we have no reason to suppose that they should die out before entering them.

In the Taipo Ranges the reefs are occurring in the lower beds of the Maitai series, which I believe to be identical with the auriferous series of Reefton. Here they are striking N.E., and crushings have given as much as 5 oz. 6 dwt. of gold per ton, but this, confessedly on the part of one of the prospectors, was from picked specimens. Notwithstanding this, the prospects of a reef which would yield the above even from picked specimens is necessarily good, and, as a road is now in progress to open up these reefs, I hope to hear shortly of their being in regular work. These are, I believe, the only known auriferous reefs from Reefton south, but, I am confident, by no means the only ones which occur. In all the alluvial workings upon a slate bottom, coarse and angular gold is found, frequently attached to quartz, and this must of necessity have been derived directly from reefs. I shall mention by-and-bye various places where gold has been found as above, and wherever such is the case it is only necessary to prospect carefully to find the reef. Many reefs have been found, as at Moonlight, etc., but they do not seem to have yielded gold in any quantity from their first crushing, and consequently have been deserted, and in many cases they have been left alone without being subjected to even so small a test as one trial crushing, simply because gold cannot be seen in hand specimens of the reef broken off. As long as the comparative apathy prevails, which, away from the immediate vicinity of Reefton, does prevail, on the subject of reefs, I have very little hope of seeing a sister district to the Inangahua started; but, should companies be started to thoroughly prospect the more promising parts of the country in a manner proposed by the company which is being formed at Greymouth to prove the value of the Moonlight Ranges, from an auriferous point of view, then I believe—in fact I am sure—that at several localities reefs will be discovered, and others which are at present known, but looked upon as useless, will be shown in many cases to contain a quantity of gold which is worth extracting. Anything of the sort is a matter for private enterprise, and not one in which the Government should have any hand. Finally, I may say that the value of a reef cannot by any means be determined on the surface, and we can only thoroughly determine the value of any proposed mine by sinking on the reef and seeing what results may be obtained from different points.

Cement Workings.

These beds, which consist of quartz gravels in a consolidated condition, occur in connection with the coal series. They vary from 1 foot to 6 feet in thickness, and have their greatest development at Cement Town, stretching from there to the head of Lanky's Gully. They also appear associated with the coal measures at the Abbey Rocks, but whether auriferous there or not I cannot say, as I do not believe they have ever been tried for gold. They are undoubtedly a river wash of the age of the coal with which they are associated, and the occurrence of gold in them is both strange and interesting. The gold appears in the lower portion of these beds, but whether as leads, or pretty regularly disseminated over the whole area, can hardly be considered as satisfactorily settled at present. But a small quantity has been worked, and the machinery used for crushing, etc., has been of the most primitive character; and, if attempts to work it up to the present time have not been successful, I am inclined to think that it has hardly had a fair trial. It is proposed to put a tunnel through the whole extent of this bed from Lanky's Gully, with the view of determining the prospect to be got throughout; and if this prove satisfactory, the crushing would be proceeded with, with every chance of success, as the getting stamps work would be a comparatively easy matter.

Alluvial Workings.

(a.) On the Slate.—These require but little attention on their own account. They occur in all gullies cut in the auriferous series, and the gold is generally coarse, and frequently associated with quartz, and evidences having only travelled a short distance.

As a guide in the search after reefs, the gold found under these conditions is valuable, it being the only class which points to the immediate vicinity of a reef. Of course, round Reefton workings of this sort may be seen in almost every gully. At Moonlight, coarse gold is also got, and again in Black Ball Creek, at Bell Hill, Seven-Mile Creek (in the Taipo Ranges), Butcher's Creek (Kanieri), in some of the creeks surrounding Mount Greenland, and in McDonald's Creek, at Lake Mapourika. In none of these cases, except at Reefton and the Taipos, have auriferous reefs been as yet found, although it is absolutely necessary for them to be here for the gold in the creeks to be derived from.

(b.) In the Conglomerate Formation.—This heading comprises a very large proportion of the sluicing claims of the district under con-

sideration. They are universally to be found in the gullies, every one of which, I think I may say, has been tried with better or worse results, as the case may be. The bottom which has caught the gold throughout this formation is the brown sandstone, which the conglomerates overlie quite conformably, and through which a colour of gold can be got at almost any point. It is, however, only in the gullies, where these conglomerates have undergone a process of natural sluicing, that the gold is sufficiently concentrated to pay for extraction.

At Ross, the gold in this formation has frequently been worked more upon terraces, and generally upon false bottoms, as many as six of these occurring in the district. We are indebted to Mr. O'Connor for a very valuable map of this district, showing the elevation above sea level of these various bottoms at different points, which was compiled with a view of settling disputes between the various claims on the subject of drainage. It is, however, invaluable for other reasons, giving much information which even now it would be impossible to obtain, and in a few years still less opportunities will offer for obtaining any history of the workings of a few years back.

(c.) In the Glacial Drifts.—At places, as at Hokitika, the Greenstone, etc., extensive and rich claims have been worked in these beds, tons upon tons of gold having been obtained from them. These are principally interesting, inasmuch as they must owe the origin of their gold, in all probability, to the slates which occur beyond the metamorphic zone, or, in other words, to the lower beds of the Maitai slates, of which the glacial drifts are chiefly composed; and they point to the occurrence of a far more extensive tract of auriferous ground than that represented by the Taipo Range, which is the only point at present at which auriferous reefs are known in these beds.

(d.) In the Black Sand Beaches.—These sands, as I have before remarked, are derived from the crystals of magnetic iron, which occur disseminated through the chloritic schists. I thought it possible that gold might occur associated with these *in situ*, but Mr. Skey's analysis has proved that this is not the case. The gold, then, must have been derived from the Maitai slates, which are brought down in such immense quantities by the glaciers. The diggers generally have an impression that the gold runs in "leads" through the sand, but I believe this idea to be erroneous, as there is no reason why it should occur in leads, and absolute observation tends far more to make it appear that it has simply been deposited in patches.

REPORT ON COAL MEASURES AT JACKSON'S BAY.

BY S. HERBERT COX, F.C.S., F.G.S.

Wellington, 14th March, 1876.

I HAVE the honour, in accordance with your instructions forwarded by telegraph to Hokitika, to make the following report on the coal measures of Jackson's Bay:—

Along the coast line north of the Jackson's Bay settlement the auriferous slates appear, overlaid by mica schists, the whole striking N.E., and dipping N.W. at an angle of from 60° to 70°. These beds, which to the north rise to a considerable elevation, fall away to the sea level before reaching the settlement, and are overlaid unconformably by limestones dipping N.W., at an angle of 35°. These limestones turn sharp up again, forming a syncline, and then marls appear below them, which rise to the summit of the saddle. It is in these marls that the coal has been found. A band of blaze runs through the marls, and occasional pockets of coal occur associated with it, but nothing of any value. I went to see the various points at which patches of coal have been found, but could not see anything which would justify any further expense being gone to for the exploration for coal at the point proposed.

In the Saddle Creek, which runs into the Smooth Water River, the marls appear near the saddle, and for some distance down the creek these beds prevail. Upon reaching the 18th peg, a band of limestone about 10 feet thick appears interstratified with the marls, which appear both above and below it. The strike of this belt of limestone is N.E., and dip N.W., at an angle of 50°.

Further down the creek, coarse sandstones somewhat tufaceous in character appear, in which I found *Cristellaria haasti*, which, with the exception of coiled *Nummulites* found in the limestone, are the only fossils found in the district. Down the Smooth Water River the bed rock is obscured for some distance until nearly reaching the mouth, where the sandstones again come in, and here assume a gritty character, and are very similar to the grits which overlie the coal at Preservation Inlet. Along the coast line from the heads to the Smooth Water River, the following sequence prevails:—

1. Limestone (highly flaky and traversed by veins of calcspar).
2. Marls (highly calcareous).
3. Sandstones and marls.
4. Conglomerates.
5. Marls.
6. Sandstones.

The general dip of these beds being N.W., at an angle varying from 30° to 40°, this dip being towards the sea.

The limestones are the highest beds seen, and are traversed throughout by veins of calcspar, and pass, by almost invisible gradations, into the calcareous marls underlying them. The whole of these beds appear to occur to a considerable extent from Jackson's Head south, being cut off immediately north of this point by the auriferous slates, in which quartz reefs are known to exist, but their auriferous character has not been proved.

The following conclusions may be drawn from the above observations :—

(1.) That coal, as already found, is of no value.

(2.) Any money spent in boring at the point proposed will be thrown away, as the marls overlie the sandstones, in which the coal would be found if it occurred at all, and consequently, even supposing that coal was known to exist, the whole thickness of sandstones, etc., exposed in Smooth Water Bay would have to be sunk through before the coal would be struck, even if the beds were lying horizontally. As all the beds are lying at an angle of 30°, or something greater, neither boring nor sinking is the proper way to prospect for coal, as any that did occur would be bound to crop out somewhere in the district.

(3.) The slates and schists occurring on the beach are too defined in the ranges and too adjacent to the marls at the point where the bore-hole was proposed to be put down to render it possible for coal to occur at that point.

(4.) The dip of the beds being towards the sea, and the strike across the Smooth Water River, it is up this river, and in the gullies which feed it, where prospecting for coal would be most likely to be attended with success.

REPORT ON COUNTRY BETWEEN POVERTY BAY AND NAPIER

BY S. HERBERT COX, F.C.S., F.G.S.

To accompany Map and Sections.

Wellington, 28th April, 1876.

I HAVE the honour, in accordance with your instructions dated 15th March, 1876, telling me to continue the survey of the country between Poverty Bay and Napier, to make the following report:—

I started from Napier on Sunday, 26th March, having previously examined the beds in the immediate vicinity of the township, and went to Pohui, on the Taupo Road, examining the strata exposed by the way. From Pohui I returned to Napier, and thence went to Arapawanui, Morangiangi, Mohaka, and thus on to Wairoa, taking note of what rocks occurred in the course of my trip, and examining them specially at points. From Wairoa I went to the Waikare Moana Lake, which I crossed in the boat belonging to the Armed Constabulary, and, having examined the beds there generally, I returned to Ohuka, where I collected some fossils, which I left to be forwarded by the Government pack-horses. I then returned to Wairoa, and there also I made a collection of shells from the *Leda* marls forming the cliffs exposed along the coast line, which was, however, somewhat meagre, owing to the proverbially small *fauna* of these beds. I also examined the beds in the neighbourhood of Tekapu. Having completed my work about here, I started for the Mahia Peninsula, passing in this part of my journey more across the strike of the beds than I had hitherto been doing—the strike having, from Morangiangi, where the *Leda* marls first make their appearance, to Wairoa, coincided more or less with the coast line, thus rendering observations taken at any one point very nearly of equal service throughout. I spent an afternoon at the Mahia, examining the strata there, but, not finding anything to warrant a further stay, pushed on for Poverty Bay, carefully noting the beds seen from time to time.

Arrived at Poverty Bay, I examined the beds exposed in Young Nick's Head, and also along the south side of the Waipaoa River, and, having convinced myself of the correctness of my diagnosis of the age of the various strata seen during my trip, by comparing them with those north of Poverty Bay mapped by Dr. Hector in 1874, I took the steamer to Napier.

I then made collections from the beds in the vicinity of Petane, which represent the higher beds of a series occurring to a considerable extent in the neighbourhood of Napier. Having completed which, I again returned to Napier, and thence to Wellington, arriving Sunday, 23rd April. The result of my survey has been as follows:—

The rocks exposed over the tract of country under consideration may be thus subdivided—

I. POST TERTIARY.

Under this head are comprised the blown sands occurring along the beaches, the alluvial deposits of the rivers, and certain deposits of pumice sand and tufaceous beds, which attain their greatest development inland, occurring only to a small extent along the coast ranges.

II. TERTIARY.

This series, the highest beds of which are represented by the shell limestone and calcareous sandy marls occurring at Petane, and also as the higher beds of Scinde Island, Napier, has a considerable development down the East Coast generally, but covers a comparatively small area in the district under immediate consideration. It occurs in the vicinity of Napier, as shown on the map, and also up the Waipaoa, at Poverty Bay, and certain beds in the vicinity of Ohuka also, in all probability, belong to the lower part of this series.

They may possibly be divided into upper and lower tertiary beds—in fact, Dr. Hector has so subdivided them in his report on the district between Poverty Bay and the East Cape—but, as I was unable to detect any unconformity from the highest to the lowest of these beds seen during my trip, I shall not make any such subdivision in my description of them, but simply mention the various beds which were seen, making such marked distinctions as were apparent from the different character of the beds themselves.

III. CRETACEO-TERTIARY.

Under this head comes by far the most extensive tract of country seen between Napier and Poverty Bay, the *Leda* marls and underlying beds of the series occurring from Morangiangi north to the exclusion of all other beds, with the exception of pumice sands, which overlie them unconformably between Waikare Moana and the sea, and extend both north and south for some distance, but more notably in a southerly direction. Although these pumice sands overlie the marls, they by no means obscure them, for the formation assumes the form of plateaux, which have been cut into deeply by the rivers which take their course from the back country to the sea. The beds have also been well exposed in cuttings made for the roads; the one from Tekapu to the Waikare Moana Lake crossing the strike of the beds throughout, and exposing them at various points in the section. They may also be well seen on the sea coast throughout, although for a considerable distance their strike corresponds with the coast line, thus rendering observations along the beach at this part somewhat uninteresting.

The Waikare Moana Lake, which is 2044 feet above the level of the sea, is excavated in the marls underlying certain coralline sandstones in the series, which rise as scarps as much as 1000 feet in height from the surface of the lake. These are the oldest beds seen in the district I have been over, the *Belemnite* beds, in which the oil springs of Poverty Bay occur, not being seen in this district anywhere south of Oil Spring Creek, where they have been mapped by Dr. Hector, until passing south of Cape Kidnappers, where they are shown by Mr. McKay as occurring on the sea coast.

Now, to allude to the various members of the different beds separately.

Post Tertiary.

With regard to these beds, very little need be said concerning them, save to point out their occurrence at different points.

At Napier, and stretching inland, a considerable alluvial flat occurs following the course of the Tutaekuri River, and representing the beds deposited by it in its flow during post-tertiary times. A spit about five miles in length, which runs from Petane towards Napier, also belongs to this formation, and stretching north, from Petane to the Whakaari Peninsula, and also following the course of the Esk, alluvial deposits of considerable extent are seen, as well as sand dunes, which latter owe their origin to the heavy southerly winds which are prevalent here.

Inland, soon after the Taupo Road leaves the bed of the Esk River, beds of tufa and pumice sand, very similar to those occurring on the West Coast, in the neighbourhood of Raglan, appear, and cover a considerable area of country, the soil of which appears to be very barren, the whole of the country being overgrown by a dense fern. This formation stretches away towards Waikare Moana, in which district it caps the whole of the cretaceo-tertiary formation, but does not occur to any very great thickness, and it is cut through in all the gullies exposing the underlying beds.

In the course of all the rivers, alluvial deposits of greater or less extent are seen, and at Wairoa these are of considerable extent, forming flats which stretch far back into the country.

From Wairoa to Mahia, considerable quantities of blown sands are seen, the Wahiki Lagoon occurring in them, or rather being banked up by them; and the isthmus between the Mahia Peninsula and the mainland is entirely composed of blown sands.

After leaving the Mahia, no alluvial deposits of note are met with until reaching Johnston's station, about fifteen miles from Poverty Bay, and from there, until reaching Gisborne, there is a considerable development of these beds. They have been mapped by Dr. Hector in the vicinity of Gisborne, so that I need not say anything about their occurrence there.

Tertiary.

The next beds which call for attention are those which I have shown on the map as of tertiary age. These beds are well seen in the vicinity of Napier, the lowest part of the series being developed at Scinde Island, and appearing again at Pohui, the higher beds of the series being seen at Petane, from which point back to Pohui a complete section can be traced, showing the following sequence :—

1. Loose brown sands.
2. Limestone
    - Shell limestone.
    - Sandy marls.
    - Marls with calcareous bands.
    - Shell limestone.
3. Brown calcareous marly sandstone.
4. Calcareous sandy marls, with belt of brown sandstone.
5. Conglomerate.
6. Blue sandy marls.
7. Napier limestone (Scinde Island and Pohui).
8. Glauconitic sands (Pohui).

At Pohui, where the lowest beds seen (Napier limestone, etc.) are exposed, they are cropping out at an elevation of 1800 feet above the level of the sea, and dipping S. 50° E., at an angle of 20°, which dip, at a short distance to the eastward, is reduced to 15°. The limestone here appears to be composed to a large extent of broken shells, together with considerable quantities of net and branching corals. *Waldheimia lenticularis*, *Panopæa zealandica*, *Venus*, and *Cardium* can also be recognized, and below these beds certain glauconitic sands appear, in which also are fossil remains, but in a very bad state of preservation.

At Scinde Island, Napier, where the typical development of these beds occur, they are forming a low anticline, dipping on the sea face S. 10°, but on the harbour side N.W. 25°, and from these beds the following shells have been described :—

Voluta pacifica
Calyptræa maculata
Pecten semiplicata
„ *secta*
„ *triphooki*
„ *accrementa*
Placunanomia
Ostræa nelsoniana
„ *wullerstorfii*
„ *ingens*
Waldheimia lenticularis.

which have been further supplemented by collections from Castle Point.

These are the lowest beds seen here, and are overlaid by sandstone and marls, which, at Pohui, have their equivalents in certain blue sandy marls, above which a belt of conglomerate of no great thickness, but of well-defined character, is seen, and may be traced for some distance. This conglomerate appears to be cemented by the peroxide of iron, and at certain points is, I believe, composed to a greater or less extent of nodules of clay ironstone, but these do not occur in sufficient quantities to render the formation of any value from an iron producing point of view.

Above this belt of conglomerate, blue sandy marls appear, and attain a considerable thickness, a belt of loose brown sandstone being interstratified with them, and the marls themselves being somewhat tufaceous in character in their higher beds, but containing fossils in a very fair state of preservation. From these beds I obtained—

Ostræa virginica
Nucula strangei
Anatina tasmanica
Calyptræa maculata
Cyclina kroyeri
Pecten radiatus
Struthiolaria nodulosa (young)
„ „ var. *papilosa*
„ *vermis*
Modiola albicosta
Zizyphinus cunninghami
Tellina deltoidalis
Turritella tricincta
Crypta contorta
Chione vellicata
„ *mesodesma*
Fenestella
Terebratella rubicunda

Mytilus sp.
Mactra elegans
Dentalium mantelli
Leda australis
Cardium striatulum
Saxicava arctica
Pinna zealandica
Natica zealandica
Veniricardia australis
Murex zealandica
Terebratella cruenta
Zenatia acinaces
Callista multistriata
Darina pusilla
Amphidotus (echin.)
Odostoma lactea ?
Mitra apicalis ?
Mysia globularis
Pleurotoma ?
Fucoid stem.

Finally, these beds are overlaid by shell limestone composed of one mass of broken shells, and from this bed I obtained—

Chione vellicata
  „ *mesodesma*
Tapis intermedia
Polydonta tiarata
Rotella zealandica
Fusus sp.
  „ *?*
  „ *zealandicus*
Buccinum sp.
Venericardia australis
Turritella sp.
Gibbula nitida
Mytilus smaragdines
Mesodesma sp.
  „ *chemnitzii*
  „ *cuniata ?*
Callista ?
Calyptræa maculata
Crypta costata
Ancillaria australis
Balanus
Panopæa zealandica
Venus zealandica
Anomiæ
Pectunculus laticostatus
Flustra
Ostræa lutraria
  „ *virginica.*
  „ *subdentata ?*
  „ *mordax*
  „ sp.

Passing from Petane towards the sea, the dip of the beds gradually becomes less, changing from S. 50° E. at an angle of 20° at Pohui, to a more easterly dip of about 10° at Petane. To the north of Petane, for some distance the higher beds only of the series are seen, and at Arapawanui they dip S.E. at a very low angle, not exceeding 5°. They consist here of the following sequence of rocks:—

1. Loose sandy beds.
2. Limestone
    - Limestone.
    - Sandy marls.
    - Marls, with calcareous bands.
3. Loose brown sands, somewhat glauconitic in character, and with hard sandy concretions.

In both of the calcareous bands numerous casts of shells appear, but in the sandy concretions of the lower beds fossil remains are best seen. From these I got *Zizyphinus cunninghami*, *Mactra*, *Fusus*, *Voluta*, *Tellina*, *Venus*, *Chione vellicata*, etc.

Further north again, in the bed of the Waipapa Creek, blue sandy marls are seen, similar to those exposed in the valley of the Esk, and containing *Pinna*, *Mactra*, *Ostrea*, etc., and they again make their appearance in the Morangiangi Valley.

After passing over the hills immediately north of Morangiangi, the coast range of hills assumes a much less elevation than it has further south; in fact, a certain low plateau of the interior sweeps round to the coast, and from there north the *Leda* marls come in. The tertiary beds, which are not seen again until in the vicinity of Poverty Bay, have a thickness at this point of over 500 feet, and the total thickness of the beds must be something very considerably greater than the above, but I have no means of estimating with any degree of accuracy what this thickness may be.

With regard to the belt of conglomerate which occurs in the Pohui section, I saw nothing more of it in its normal position after leaving Petane, on my journey north; but at Mohaka a band of conglomerate, very similar in character, occurs overlying unconformably the *Leda* marls, but whether these are the same beds, or whether they are more recent, I cannot say.

The tertiary blue marls of Waipapa Creek and Morangiangi overlie the *Leda* marls unconformably, and a decided unconformity exists between the *Leda* marl series and the younger beds generally which occur in the vicinity of Napier, overlapping one another above the underlying *Leda* beds.

Certain green sands belonging to this formation also occur in the vicinity of Okuka, but cover a comparatively small area; indeed, I was unable to trace them for any distance, but they do occur here to a small extent.

Cretaceo-Tertiary.

The cretaceo-tertiary series, the oldest beds which appear, must be of very considerable thickness. Captain Hutton* has estimated them at 7000 feet, and they cover a great extent of country. Passing north from Napier, these beds are first seen on dropping into the lower plateau country through which the Mohaka takes its course, and after passing the Morangiangi River, at which point they are dipping S.E.

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* Capt. Hutton, Geol. Rep., 1869, p. 7.

15°, their strike coinciding very nearly with the coast line, they may be looked upon as occurring uninterruptedly along the coast line until reaching, or nearly reaching, Poverty Bay; while inland they may be traced as far back as Waikare Moana Lake, it being in the lower beds of this series that the lake itself lies. These beds, which have been classed under the general term of cretaceo-tertiary series, merit some further subdivisions, which I shall make as follows, the whole series probably corresponding with the chalk group of the Amuri Bluff:—

1. Upper marls.
2. Middle marls and calcareous sandstone.
3. Lower marls.

Those coming under the division of upper marls, are of a light colour and greasy character. They are the highest beds seen of the series, and contain the greatest number of fossils in the localities which I examined. From a collection made by me from these beds, at the mouth of the Wairoa, I obtained *Cristellaria haasti*, *Nummulites*, *Dentalium*, *Turbinolia*, *Echinoderms*, *Globigerina*, *Terebratella*, *Natica*, *Nucula*, *Modiola?* *Cardium*, *Pecten hochstetteri?* *Fusus nodosus*, carbonaceous markings, fish scales and rays, microscopic shells (not worked out), round and flattened tubes.

These beds occur, for the most part, from Wairoa south along the coast line, where they are striking S.W., nearly parallel to the coast, and dipping S.E., at an angle of 15°, as before mentioned. They also stretch inland for some distance, being, in the neighbourhood of the Wairoa, the beds composing the principal part of the country until passing Okuka on the road to the Waikare Moana Lake. Before reaching this point, an anticline and subsequent syncline are passed, and then, until reaching the Waikare Moana Lake, the dip of the beds, which is still to the eastward, has assumed a somewhat higher angle, at about 20°, and we begin to get into the middle marls and calcareous sandstone, which forms the second division of these beds.

At Okuka, brown sands occur overlying the marls, and, as before mentioned, certain green sand tertiary beds also occur in the vicinity. I was unable to detect any fossils, except a *Leda*, in these brown sands, but they overlie the marls quite conformably, and no doubt belong to the series. Upon reaching the middle marls and calcareous sandstone, fossils become very scarce; indeed, I can only record having found the round and flattened tubes which occur also in the upper marls. They are, in all probability, the equivalents of similar beds in the *Leda* marls at Poverty Bay, in collecting from which Mr. M'Kay* obtained *Pecten zittelli*, *Nummulites*, *Leda*, etc., and careful searching in this locality would probably result in the discovery of fossils; but in the course of my work I was unable to find any.

A very considerable development of these beds is seen in the vicinity of the Lake. They consist of alternations of marls, which are considerably harder than those of the higher beds occurring near the sea coast, in addition to which they possess a more or less concretionary or conchoidal structure, and a hard calcareous sandstone, which is somewhat glauconitic in character. The alternations of these beds, in which the sandstone predominates, rise as bold scarps on the south-east side of the Lake, at points, as at Paniheri, as much as 1000 feet above the level of the Lake. They pass in their lower beds into a greater development of marls, which are much darker in colour than those occurring in the higher portions of these beds, and possess the conchoidal structure to a high extent which is so marked in the black marls of the West Coast of the Middle Island, and they are doubtless the equivalents of these beds. I failed to obtain any sign of fossils from them, with the exception of the tubes before mentioned as occurring throughout these beds.

It is probably in these lower marls that the Lake has been excavated, for on its north-west side hard sandstone beds again appear, with thin interstratifications of marls, the sandstone running out into the Lake as long smooth reefs, which show the bedding most perfectly. I was unable to trace these beds any further westward, as all the country lying in that direction is under Maori rule, so I did not see the bottom of the series.

It is difficult to say how this Lake has been formed, as it shows no sign of glacial action, and the hypothesis which finds general favour in the district—that it is the crater of an extinct volcano—is, of course, simply absurd. The general formation of the country near the Lake shows the bedding in a most perfect manner, the hills rising as abrupt scarps to the N.W., and sloping gradually away at an angle of about 20° on the S.E. side, this not being in the least obscured by the pumice sands which overlie the whole formation to a greater or less extent.

After leaving Wairoa, in the direction of the Mahia Peninsula, the strata are crossed at an oblique angle to their strike. In the vicinity of Nuhaka a belt of hard sandstone comes in, and the dip is

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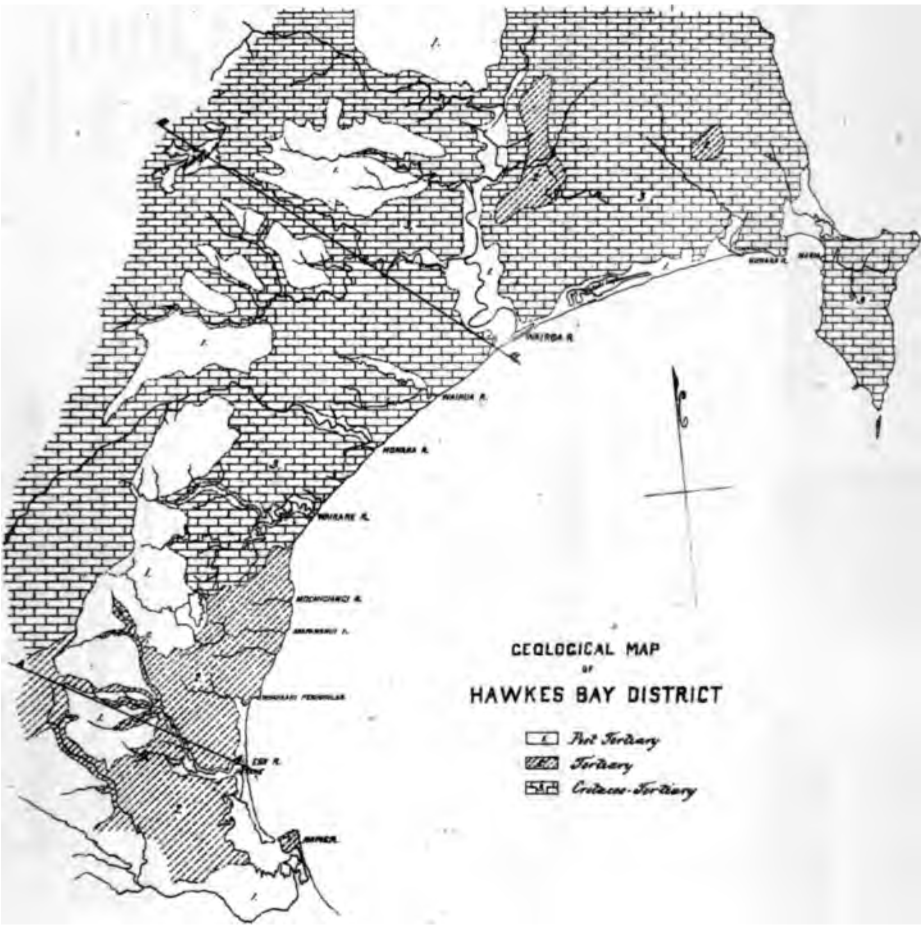
* Geol. Reports, 1874, p. 157.

Geological Survey of New Zealand.

JAMES HECTOR, M.D., F.R.S., DIRECTOR.

To illustrate Report by S. Herbert Cox, F.G.S., Assistant Geologist. April 28, 1876.



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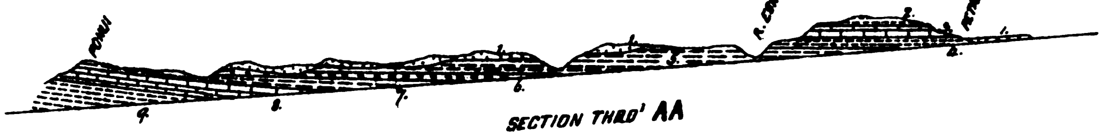
SECTIONS

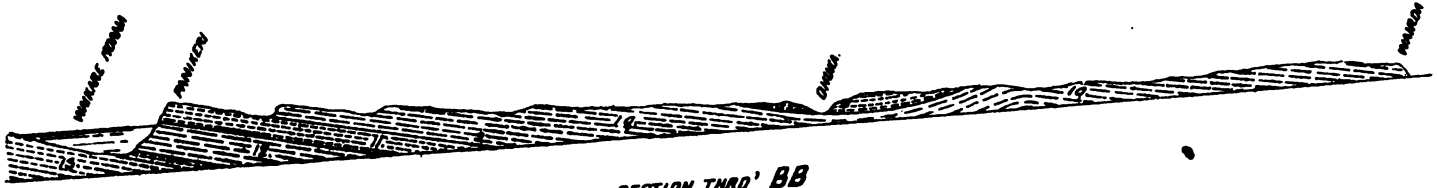
HAWKES BAY DISTRICT

1. PUMICE SANDS
2. LOOSE BROWN SANDS
3. LIMESTONE { SHELL LIMESTONE / SANDY MARLS / MARLS WITH CALC: BANDS / SHELL LIMESTONE.
4. BROWN CALCAREOUS MARLY SANDSTONE
5. CALCAREOUS SANDY MARLS WITH BELTS OF BROWN SANDSTONE
6. CONGLOMERATE
7. BLUE SANDY MARLS
8. POHUI LIMESTONE
9. GLAUCONITIC SANDS, POHUI.

10. UPPER MARLS
11. MIDDLE " AND CALCAREOUS SANDSTONE
12. LOWER "
13. CALCAREOUS SANDSTONES AND GRITSTONES



SECTION THRO' AA



SECTION THRO' BB

to the N.W., at a low angle, the beds, as far as I could determine, belonging to the lower part of the series, or those which are found surrounding the Waikare Moana Lake. These beds are further developed at Waikokopu, where they occur to a considerable thickness, and pass in their lower beds into tough clay marls, the dip being N.W., at an angle varying from 10° to 5°. They form the Mahia Peninsula, where fossils are not more plentiful than at other places where these beds appear, round and flattened tubes being almost the only trace of organic remains to be found. They are here much faulted across their line of strike, and the beds of sandstone interstratified with the marls may be seen continually thrown to all levels.

Here, at the Mahia, the dip of the beds is to the N.W., at a very low angle, 5° being as much as it is on an average; but, passing in the direction of Poverty Bay, the angle of dip gradually increases, until, on reaching the highest point of the range, the dip of the beds is N.W., at an angle of 25°, and, after passing this point, they dip away to the S.E. once more. The strike of these beds, where they are dipping N.W., at an angle of 25°, would carry them through to the outcrop of cretaceo-tertiary beds on the coast line north of Gisborne, where they are standing at a higher angle still.

Dr. Hector mentions that where these beds are seen in the East Cape district, that they are all standing at high angles, and, coming north, I have noticed that the dip gets higher, and also that the beds are generally lying at higher angles inland than on the sea coast.

This completes a description of the beds seen throughout my trip, and reference to the maps and sections accompanying this report will serve to further elucidate their extent and mode of occurrence.

REPORT ON SURVEY OF BULLER COAL FIELD.

BY S. HERBERT COX, F.C.S., F.G.S.

To accompany Maps and Sections.

Wellington, 13th June, 1876.

I HAVE the honour, in accordance with your instructions dated 2nd May, 1876, to make the following report on the progress of the survey of the Buller Coal Field during the past year :—

The coast line has been surveyed from Westport to the Waimangaroa, a line has been carried on from there to Nikau Creek, and some of the spurs have been traversed from the higher to the lower levels, shewing what facilities exist for the transport of coal.

The area which has hitherto been known as the "Cascade Creek Area," but which Mr. Cooper has re-named "Todea Creek"—finding that the creek in which the coal occurs is one which has been hitherto unnamed, and which falls into the Buller at a point nearer Westport than Cascade Creek—has been surveyed. Mount Rochfort and the Rochfort Plateau, from Coalbrook Dale to the sea, have also been completed, and the Upper Orikaka country is now nearly finished.

It will thus be seen that the survey of the principal coal areas of the Buller coal field are now almost completed between Westport and the Ngakawau, the country between the Ngakawau and the Mokihinui not having as yet been touched, save that a north and south line has been started, connecting the Upper Orikaka with the Mokihinui River.

Mr. Denniston has followed Mr. Cooper in his work, plotting the coal outcrops, and to him I am indebted for the sections which accompany this report. I shall have to speak of the various areas which have been surveyed separately, and, in so doing, I shall mention them in the following order :—

1. Todea Creek (Overhagen's Cascade lease).
2. Mount Rochfort and plateau.
3. Sea slopes with slip coal.
4. Upper Orikaka country.

1. Todea Creek (Cascade Area).—Coal has been traced in this area, showing a greater extent than would be expected from the appearance of the country, as seen from the edge of the break forming the boundary of Coalbrook Dale. At the head of Todea Creek, south-west from the Mount William summit, slates appear at the surface, but, descending the creek, coal 3 feet thick is first seen, interstratified with bands of blaze, and, on passing southward from this point, it thickens out to 25 and 30 feet, and is lying at comparatively low angles.

The following sections show the thickness of the coal at various points down the creek:—

Head of Todea Creek.

(1.) Surface	Ft.	in.
Fine sandy grits	35	0
Soft dark flaky sandstone, with dark partings	6	0
Dark sandstone	4	0
Coal (lower seam)	3	0
Dark flaky sandstone	3	0
Soft grey shaly stone	2	0
Coarse hard grit	20	0
Slate to bed of creek		

Dip S. to S.E. 5°.

South from above.

(2.) Upper measures same as section (1)	Ft.	in.
Coal (lower seam)	8	0

South of Section 2, about 14 chains.

(3.) Surface		
Fine sandstone, with dark partings	8	0
Fine sandy grits	30	0
Dark flaky sandstone	10	0
Coal (lower seam)	20	0
Soft grey shaly stone	10	0
Coarse hard grits, with fragments of sandstone	80	0
Slate to bed of creek		

Dip S. to S.E. 10°.

These sections are in the terrace face, and the measures appear to hold solid back to the face of the break, as seen in the tributaries of Todea Creek. It is, therefore, probable that this seam of coal holds over the whole of this area until reaching traverse peg 93, which is the boundary of a second break, which I shall have to speak of further on.

Further down the creek the coal thickens out to 40 feet, and then commences to thin again, the dip still being S. to S.E., until, on reaching a point about four chains south of peg 87 of the traverse line, where the traverse line down Overhagen's Spur joins the V 4 line, the coal is lying flat close to the bed of the creek, and showing the following section :—

		Ft.	in.
(4.)	Fine soft yellow sandstone	50	0
	Soft flaky sandstone	1	0
	Coal (lower seam)	20	0
	Hard grits to creek	20	0

And, after passing this point, the dip changes to the northward, the coal again rising above the bed of the creek.

At the mouth of Overhagen's Creek, the following section is seen :—

(5.)	Surface	Ft.	in.
	Coal (lower seam)	30	0
	Fine hard grits	25	0
	Granite to bed of creek	45	0

Dip N. to N.E. 15°.

And about fifteen chains further south still, the coal has been raised to a considerable elevation above the bed of the creek, and the following section is exposed :—

(6.)	Surface	Ft.	in.
	Fine sandstone	12	0
	Soft flaky sandstone	1	0
	Coal (lower seam)	25	0
	Soft grey shaly stone	3	0
	Hard grits	38	0
	Granite to bed of creek		

Dip N. to N.E.

South of this point the country becomes very rough, the coal thins out, and ultimately no signs of it are seen, the last remnants having been denuded, the granite which forms the Rochfort Ridge appearing at the surface; while, to the westward of the above sections, the country is also very broken, the crowns of the spurs showing at places the lower coarse hard grits, and at others the slate coming to the surface.

The general formation of the Todea Creek area is as follows:—A slip has occurred from the face of the Coalbrook Dale break, bringing the coal contained in the area from traverse peg 93 north—exposed in sections (2), (1), (3)—and also that further south—exposed in section (6)—to their present level. Subsequently another slip has taken place along a line of break running north and south, about sixteen chains to the eastward of that forming the boundary of Coalbrook Dale, which has brought the coal contained in the area from traverse peg 93 south to Overhagen's Creek—exposed in sections (4), (5), etc.—to a still lower level, giving an area of coal from 20 feet to 30 feet thick, as seen in the above sections, and about five chains in width. Along the east bank of the creek, opposite sections (4) and (5), small patches of coal also occur at the same level, being shortly cut off again by the slates and granite.

The height of the first slip, that containing the coal at the two extremities of the Todea Creek area, is 400 feet to 450 feet between the coal on the plateau and that in the slip; while the drop in the second slip is 850 feet from that in Coalbrook Dale. In the upper of these two areas the coal is as sound as that in Coalbrook Dale, while the lower, though slightly shaken, is still a good marketable article. The thin upper seam does not appear to occur in this area at all, having most probably been removed by denudation.

After passing the Mount Rochfort Ridge, no further sign of coal is seen down the creek until reaching the Buller River. The country is very rough, consisting of slate and granite, intersected by steep gullies.

2. *Mount Rochfort and Plateau.*—A continuance of the Coalbrook Dale seam, mentioned in my last year's report, has been traced westward through the country in which the River Whareatea takes its rise. Sections of the coal have been obtained on both the eastern and western sides, in the heads of certain branches of Todea Creek, and near where Trent's line crosses the Whareatea River, as follows:—

		Ft.	in.
(7.)	Soft sandstone	12	0
	Coal (lower seam)	18	0
	Blaze	4	0
	Crushed grits	20	0

Dip N.E. 20°, resting upon slates, the coal being much crushed.

		Ft.	in.
(8.)	Blaze	2	0
	Quartz grits	30	0
	Soft sandstone	20	0
	Coal (lower seam)	6	0
	Dark grey stone (troubled) ...	10	0

Dip irregular, but southerly, resting upon slates.

There is no doubt that the coal extends through the intermediate area, holding a thickness of from 6 feet to 18 feet, thickening towards the eastern boundary, and thinning westward, as in Coalbrook Dale. This coal is cut out to the westward by the slates, which come to the surface near the centre of the plateau, and from there to the western edge of the plateau no coal of any value has been traced.

In the vicinity of the bore-hole which was put down near the edge of the Waimangaroa break, the following sections are obtained:—

		Ft.	in.
(9.)	White quartz grits	50	0
	Blaze, with bands of stone	10	0
	Coal (crushed)	4	0
	Dark shale and soft sandstone ...	8	0

Dip W. 15°, resting upon hard sandy grits.

		Ft.	in.
(10.)	White quartz grits	20	0
	Blaze	6	0
	Coal (crushed)	3	0
	Blaze, shale, etc.	8	0
	Sandy grits	20	0
	Blaze	5	0
	Soft sandstone grits	30	0
	Blaze	2	0
	Coarse grits	120	0
	Blaze	4	0
	Hard coarse grits	35	0
	Blaze	2	0

Dip W. 15°, resting upon hard coarse grits.

South from this point no sections have been obtained holding coal, but the following section is seen in a tributary of the Whareatea:—

		Ft.	in.
(11.)	Blaze	1	6
	Sandy grits	25	0
	Blaze	1	0

	Ft.	in.
Red grits	30	0
Blaze	1	0
Fine to coarse grits	20	0
Blaze	3	0

Dip W. 15°.

The Whareatea itself has cut deeply into the coal measures, but no outcrops of coal are seen. Bands of blaze appear from time to time, and, to the eastward up the Waimangaroa Gorge, sections of the strata are obtained from the surface down to the slate, not however exposing coal of any value. The following section is typical:—

(12.) Surface (edge of plateau)	Ft.	In.
Soft sandy grits	28	0
Blaze	2	0
Grits	4	0
Blaze	4	0
Soft sandstone, with partings of blaze	30	0
Grit	4	0
Soft red sandstone	20	0
Blaze	1	0
Grits	1	0
Blaze	1	0
Coal	0	6
Blaze	0	6
Soft dark sandstone, with shaly partings	18	0
Soft red grit	18	0
Dark sandstone	10	0
Quartz grits	14	0
Blaze	0	9
Coal	0	3
Blaze	2	0
Hard grit	12	0
Coarse hard grit	24	0
Coarse stone, with angular fragments of quartz	40	0

Dip N.W. 12°, resting upon slate.

The crops of the various beds have been run out to the surface eastward of this point, and show that no coal other than the thin seams appearing in the sections may be looked for in the plateau between the Waimangaroa and Whareatea Rivers, lying to the westward of the slate ridge previously mentioned. South of the Whareatea, until passing the summit of Mount Rochfort, patches only of crushed coal near the edge of the break are seen, the country generally presenting the appearance of a vast area of denudation. From the Orawaiti River to the Buller, along the high levels small patches of crushed sooty coal are seen, until the granite, through which the lower gorge of the Buller is cut, comes to the surface.

To sum up the results obtained by the survey of this district, it appears that, south of the Waimangaroa River, the coal which appears on the high levels west of the slate ridge is of very limited extent and thickness, in addition to which such coal as does occur is of so crushed and sooty a character as to be worthless, and the area may be looked upon, from a practical point of view, as being barren of coal.

3. Sea Slopes with Slip Coal.—Coal has been traced from L. 116, near the edge of the Mount Frederick Plateau, to the head of Sims' Spur, north side of the Waimangaroa, sections being seen on both sides of the spur, as follows :—

		Ft.	in.
(13.)	Yellow sandy grits	18	0
	Soft sandstone, with shaly partings ...	2	0
	Sandy grits	1	6
	Sandstone, with shaly partings ...	3	6
	Dark shaly sandstone	4	0
	Yellow sandstone	1	0
	Blaze	2	0
	Coal	25	0

Dip N.W. 15°, resting upon slate.

		Ft.	in.
(14.)	Yellow sandy grit	25	0
	Soft sandstone, with shaly partings ...	1	0
	Sandy grits	3	0
	Sandstone, with shaly partings ...	3	0
	Dark sandstone	4	0
	Hard yellow sandstone	3	0
	Blaze	1	0
	Coal	20	0

Dip N.W. 5°.

The coal of this area is of the same superior quality as that generally found through the plateau heights, and it holds steadily throughout

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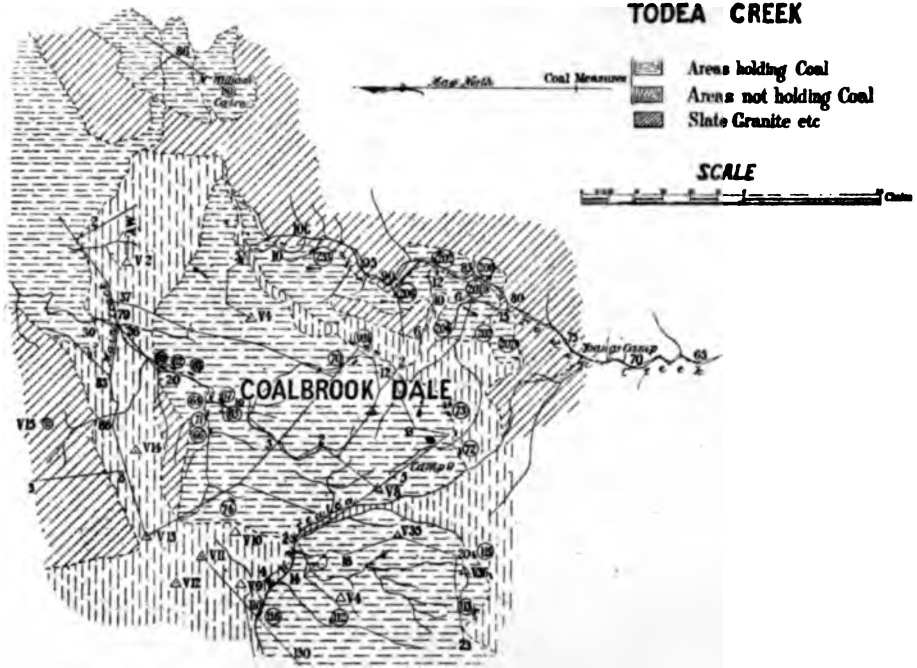
BULLER COAL FIELD

TODEA CREEK



To illustrate Report by S. Herbert Cox, F.G.S., Assistant Geologist. June 13, 1876.

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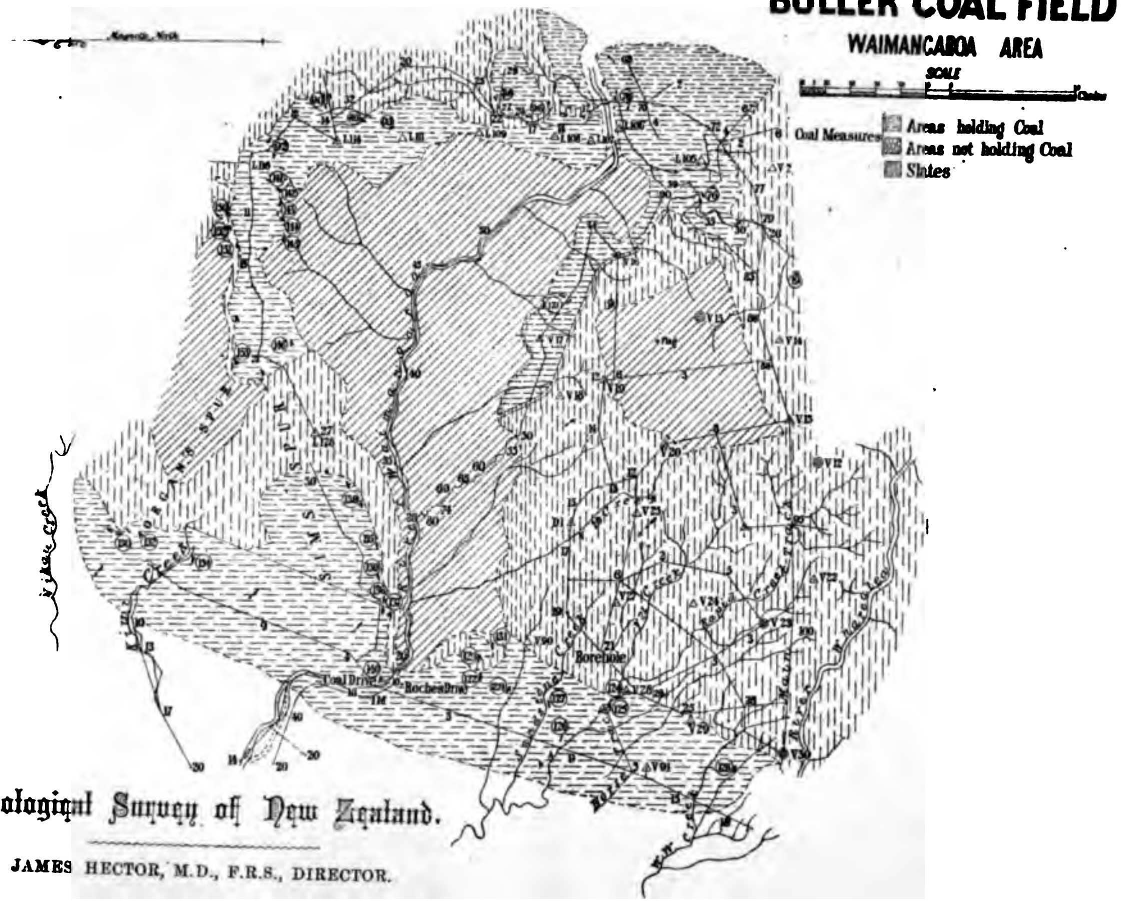
BULLER COAL FIELD

WAIMANGAROA AREA



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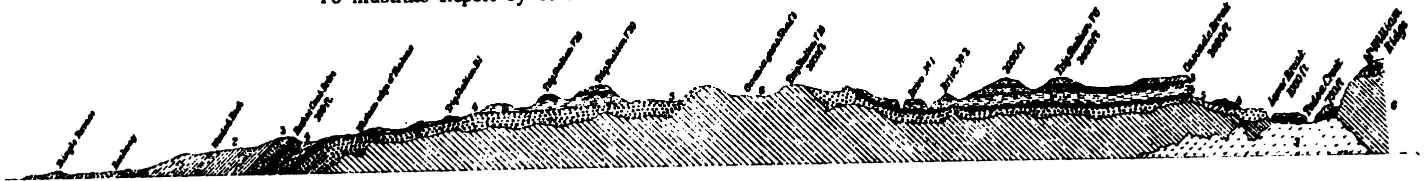
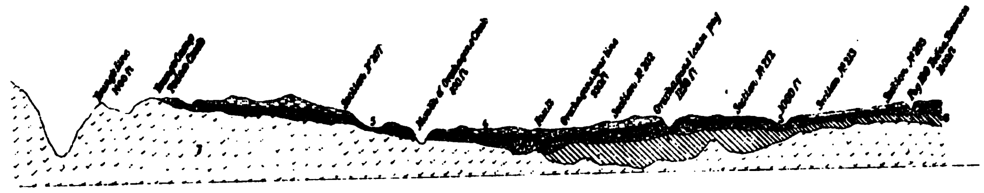
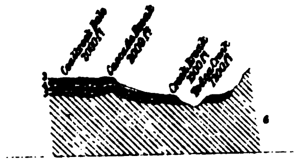


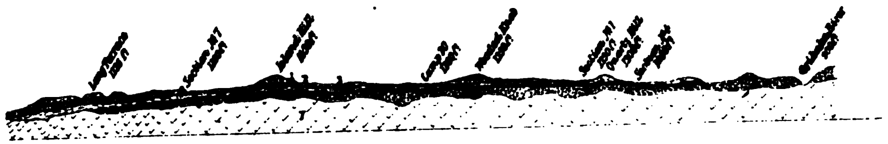
SECTION FROM SEA FACE TO COALBROOKDALE



SECTION DOWN TODEA CREEK



SECTION DOWN V4 LINE. TODEA CREEK



SECTION THROUGH OHIKANUI VALLEY N.S.

BULLER COAL FIELD

1 ▨ Alluvial Wash
2 ▨ Black Marls
3 ▨ Brown to Grey Sandstone *(fossil oysters)*
4 ▨ Sandstone & Sandy Grits
5 ▨ Coarse Grits
6 ▨ Slate & Schist
7 ▨ Granite
— Coal

SCALE

Chains

the area until cut off by a fault crossing the spur in a north and south direction, near peg 15 of Sims' Spur traverse line. Below this an area of crushed coal occurs, about 50 chains in length, and it has been exposed by grit pits, till near peg 23 on the same traverse. From this point the spur forks—that known as Organ's Spur running in a north-west direction, while Sims' Spur runs to the south-west—and down these spurs a denuded area is first met with, showing, on Organ's Spur, slate exposed to the surface, till coming to the edge of the main break; while, on Sims' Spur, broken grits and slate are seen until reaching peg 30. At the edge of the main break a small area of soft coal is met with, which has been exposed by trenches on the slopes, the following sections being seen:—

		Ft.	in.
(15.)	Blaze	10	0
	Coal (good)	15	0
	Blaze, with band of coal	14	0
	Coal (soft)	16	0
	Shale	2	0

Dip N.W. 25°.

		Ft.	in.
(16.)	Surface	3	0
	Soft dark sandstone	6	0
	Coal (good)	16	0
	Blaze, with band of coal	10	0
	Coal (soft)	4	0
	Soft brown sandstone	35	0

Dip N.W. 30°.

		Ft.	in.
(17.)	Blaze		
	Coal (good)	16	0
	Shale and coal, with band of blaze	14	0
	Coal (soft)	16	0

Dip N.W. 20°.

The coal here is of good quality, but soft, and it remains to be seen whether it will improve on driving.

Below the break on Organ's Spur, a face of crushed coal is seen, probably dipping N.W. No other outcrops can be traced here, the surface being covered by *débris* from the heights above.

On Sims' Spur, the crushed coal has been exposed near the surface by cutting trenches, and in Sims' drive, at the Waimangaroa, the following section is seen:—

	Ft.	in.	
Surface	2	6	Dip W. 40°.
Dark soft marly sandstone	90	0	
Fine grits and sandstone	80	0	
Dark sandstone	60	0	
Coal	0	6	
Dark broken grits	40	0	
Shale	2	0	Dip W. 60°.
Shale and broken sandstone, with grits	40	0	
Shale	4	0	
Shale and sandstone, with grit ...	20	0	Dip E. 70°.
Shale	2	0	
Dark sandstone	4	0	

and, at a distance of 120 feet from this point, coal has been cut 18 feet thick, dipping W. to N.W., at an angle of 60°. This coal is soft in character where first struck, but, on being driven upon, appears materially to improve, and will very likely prove of better quality when it gets under the hill. The dip also decreases as the drive is put forward, and the coal is now lying at an angle of from 35° to 40°. It is probable that this coal extends from Organ's Spur on the north to Sims' Spur on the south, so that, if the quality of the coal improve, this area will be of considerable value.

On the south side of the Waimangaroa, in Roche's drive, a seam of crushed coal 18 feet thick, dip W. 40°, has been struck. This seam has been traced to the southward, with the following results. About ten chains south-east from Roche's drive the following section is seen :—

		Ft.	in.
(18.)	Surface	3	0
	Fine grits	10	0
	Blaze	1	0
	Coal	1	0
	Blaze	1	0
	Coal	1	0

Dip W. 50°, resting upon dark shale.

About four chains east from section No. 18, loose crushed coal is seen occurring in the sidling of the spurs, and, continuing up the spur from here, coal may be seen at places on the surface until reaching a section, where a trench has been cut, exposing a seam of crushed coal 18 feet thick, without any solid roof, the quality being the same as at Roche's drive.

At section No. 19 another trench has been cut, and the following section exposed :—

		Ft.	in.	
(19.)	Clay marls			
	Dark sandstone			
	Grits	20	0	seen.
	Blaze	2	0	
	Sandstone	4	0	
	Coal and blaze	1	0	
	Fine grits	20	0	
	Dark sandstone	80	0	
	Band of grit	6	0	
	Soft sandstone	8	0	
	Coal	1	0	
	Blaze	1	0	
	Grey shaly grits	1	0	
	Fine sandy grits	30	0	
	Blaze	4	0	
	Fine grit	35	0	
	Dark sandstone	40	0	

Dip W. 40°.

About twenty chains south from this point, the following section is seen in Rapid Creek :—

		Ft.	in.
(20.)	Coal (crushed)	3	0
	Dark brown sandstone	14	0
	Soft red sandstone	12	0
	Coal	2	0

Dip W. 40°.

and going still further south, in a tributary of the Whareatea, we find the beds as follows :—

		Ft.	in.
(21.)	Blaze	1	6
	Sandy grits	25	0
	Blaze	1	0
	Red sandy grits	30	0
	Coarse grits	30	0
	Blaze	1	0
	Fine to coarse grits	80	0
	Blaze	3	0

From the above sections it will be seen that not only does this area not hold coal of a marketable quality, but that on going south from Roche's drive what coal there is rapidly thins out, or passes into blaze, so that, practically, I am afraid this area is of little value.

South from the Whareatea, until reaching the Orawaiti, a belt of auriferous wash occurs flanking the ranges. This is resting upon a sandy bottom, which is followed by a coarse wash resting upon black marls containing nodules of clay band ironstone.

From information gathered from miners, Mr. Denniston reports that this wash has been driven into for a distance of 2,000 feet, and the slopes to the eastward of this are so covered by *débris* as to render it impossible to obtain reliable information from them. However, from what can be seen, it is extremely improbable that any coal of value will be found in this area, and the same remarks apply to the country from the Orawaiti to the Buller.

North of Nikau Creek, until reaching Granity Creek, no explorations have been carried on. The country presents a very rugged and broken appearance, consisting of long narrow spurs, the slate coming to the surface. It is probable that patches of coal, similar in quality to that on Sims' and Organ's Spurs, might be found on the lower levels, and, as these spurs may form the outlet for some of the best coal, I think some work should be expended upon them with this object in view.

4. Upper Orikaka Country.—The survey of this part of the country, which is situated on the eastern side of the Mount William Range, is at present being carried on—indeed, by this time, should be nearly completed.

Both seams of coal occur in this area, the upper seam being thin, as at most other parts of the field. The lower one varies in thickness from 4 feet up to 25 feet, and is of good quality. On the eastern slopes of the Mount William Range—the western side of the Tio Valley (Upper Orikaka)—small hillocks occur, containing coal, varying in thickness from 1 foot to 3 feet, the lower coarse grits appearing at the surface in the creeks, schists and slates also appearing. At the base of the ridge, coal occurs abutting against the lower grits, and standing on end in a tributary of Tio Creek; while north of this, at section No. 21, the following sequence is seen :—

		Ft.	in.	
(21.)	Black marls	350	0	judged.
	Micaceous sandstone, with fossil oysters	30	0	
	Soft band of blue shaly stone ...	1	0	
	Coal (upper seam)	1	0	

Dip E. to N.E. 15°.

Further north still the lower seam crops at a distance of about twenty chains from the above section, thus—

(23.)	Ft.	in.	
Surface			
Coal (lower seam)	10	0	shown.
Soft sandstone	12	0	
Coarse hard grits			
Dip E. 8°.			

Coal has not been traced further north than this, but to the east, across the valley, the measures are lying almost flat, dipping however slightly to the north, and further across the valley it changes to a north-west or westerly dip, and the coal appears to basin. The black marls there cap the measures, and overlap them, nothing but the lower grits appearing below the marls on the eastern boundary of the field.

I am unable to show the extent of the coal beds, as the maps are not at present far enough advanced, but Mr. Denniston's sections, which are appended to this report, give a fair idea of the lay of the coal, and the extent may be classified in the following manner:—

1. Along the eastern face of the Mount William Ridge, coal occurs in patches.
2. In the Orikaka Valley, from the divide of the Orikaka and Ngakawau Rivers, south, coal is also seen in patches, but probably does not hold throughout the area.
3. From the divide, north, as far as at present been seen, viz., to the Long Terrace, it is probable that both the upper and lower seams hold, but would have to be worked by shallow shafts, which would be disadvantageous as compared with the other parts of the Buller Coal Field.

Above the upper seam a belt of micaceous sandstone occurs, in which large oysters have been found, these being overlaid again by black marls, as seen in section No. 7, which cover a considerable area here, flanking the slate ranges still further east. The sandstone in which the fossils occur is similar to that which overlies the upper seam of coal in Sims' drive. It is highly sulphurous in character, owing probably to the decomposition of pyrites.

Facilities for Transport of Coal.—I have further to point out certain points relative to the working of the coal. I mentioned in my last year's report that the coal of Cable and Drummond's lease would best be worked by a tramway from the face of the coal to the Ngakawau. Another route also presents itself by which this coal could be taken, viz., down Granity Creek; but, although this would be cheaper means of exit as far as first expense is concerned, the other route would, I believe, be the best for a permanent way.

Any company that made a tramway here would have to act as common carriers for the greater part of the coal field, and it would certainly be to their advantage to make such tramway of as permanent a character as possible.

The Coal of Mulholland's Lease, which is about to be worked by a Wellington company, simply requires a branch line along the banks of the Waimangaroa to connect it with the main line, but whether this should be constructed on the north or south side of the river is a matter for consideration. Should the north bank be chosen, the necessity for a bridge across the river opposite the mine would be obviated; while, on the other hand, if Messrs. Roche and Company's lease be worked, one line from the railway depôt, up the south side of the river, would suffice for the working of the two mines.

Beyond the working of these two leases, the south bank possesses but few advantages over the north, as the Coalbrook Dale area could not be conveniently connected with this line; whereas the Korinui Company would probably bring their tram down close to Sims' drive if the branch line were constructed, so that the question of on which side of the river the line should be laid down simply resolves itself into one of the natural advantages which present themselves for the construction of a line.

The Korinui Company's Lease, which is situated at the head of Sims' Spur, and contains coal of a superior quality and hardness, may readily be worked by self-acting trams from the face of the coal in the Waimangaroa break to the railway, down Sims' Spur from L 128, and from there to the face of the coal, along gently sidling ground. If this Company push their work on, as they profess it is their intention to do, they will, in all probability, be the first to have genuine hard coal in the market; for, although the coal in Mulholland's lease shows signs of improvement on being driven on, still it is not equal to that of the high levels, nor do I think it will ever prove of as good quality.

I understand that it is proposed by the Coalbrook Dale Company to lay a permanent way across the Mount Rochfort plateau to the head of Roche's Spur, and self-acting tramways from there to the railway depôt, at Waimangaroa, down the south side of the spur; and Mr. Denniston informs me that such a tramway could be constructed without any very great difficulty. There will, however, of necessity be a great expense incurred in the construction of a tramway of this length, but I can see no other means by which this area can be worked at all.

The coal here is of the best quality upon the field, and will be worked at a minimum cost, irrespective of the transport, so that there is encouragement for the speculators to incur a large first expense.

The Todea Creek Coal is dependent upon Coalbrook Dale for means of egress, the difficulties of a tramway down Todea Creek, as pointed out by Mr. Denniston, being too great to warrant such an one being constructed. Should the line be laid across the plateau, as proposed, this coal would probably be worked almost as cheaply as any in the field, and would simply involve the erection of a winding engine, to draw the trucks from the coal in Todea Creek to the level of the plateau. A good line for this could readily be constructed down the V4 line, at a small expense, and when it is considered that the whole area could be worked level free, that coal could be put into the market very shortly after opening the mine, added to which there is a good supply of timber, which would serve for the construction of the line, and also for timbering the workings, I think the prospects of this area may be looked upon as encouraging.

The Coalbrook Dale area is almost devoid of timber, and they would probably have to get what they require from Todea Creek, so that they also would benefit by the construction of a tramway to work the coal here.

With regard to the Korinui Company's tramway, a good supply of timber exists along the proposed line, which would serve for construction and also for subsequent workings, and the same remarks apply to that down Roche's Spur, where the Coalbrook Dale tramway would pass.

The Upper Orikaka Country is very badly situated, as regards means of egress for the coal, and I fear it will be many years before any attempt be made to work it.

Further Prosecution of the Survey.—As mentioned in the early part of this report, the survey of the principal coal areas between Westport and the Ngakawau is now completed, with the exception of the spurs between Nikau and Granity Creeks. A line is now in progress connecting the Upper Orikaka country with the Mokihinui, and Mr. Cooper informs me that he hopes to have this through in another month. This will give a better idea of what may be looked for between the Ngakawau and Mokihinui, of which block of country little is at present known. When this line is through, I think the spurs between Nikau and Granity Creeks should have some work expended upon them, with the view of determining which is the best means of exit for some of the high level coals, which may possibly be better worked this way than any other. When this is completed, I do not think any further field work should be carried on in this district until the maps are as far advanced as is possible from the information which is at present to hand, unless the Mokihinui present favourable indications from the preliminary work attendant upon cutting the line through from the Upper Orikaka to the Mokihinui River, in which case it would be advisable to continue a survey of this block as rapidly as possible.

DETAILED NOTES ON THE BULLER COAL FIELD.

BY ROBERT DENNISTON, Coal Viewer.

With Map and Sections.

Westport, October, 1876.

1. I HAVE the honour to report that I undertook my duties, as Coal Viewer, on the 19th October, 1874, and proceeded, as instructed, to the River Ngakawau, there commencing my explorations at a point known as the Albion Company's workings, working south and east on to the plateau heights covering the west slopes and summits of Mounts Frederick, William, William Ridge, and Mount Rochfort, further working south till reaching the lower gorge of the Buller River; also, extending my labours eastward into, and through part of, that area of country situated to the east of Mount William, and that of Mount William Ridge, known as the Tio (Orikaka) Valley; exploring from the divide of the waters of the Orikaka flowing south towards the Buller, and those of the Upper Ngakawau flowing northward, and extending my labours northward till reaching the Mokihinui River. My labour generally throughout has been employed in tracing the coal underlying the area gone over, by surface explorations; in noting and taking measured sections of the coal measures where practicable; in plotting the outcrops found in their various positions on the working plans provided, which will be found numbered on plans, from No. 1 and upwards; likewise sheets of sections obtained will be found herewith.

The northern, or Ngakawau, portion of the field (sheet No. 9), I have divided into arears, which will be found numbered from No. 1 to No. 8; while that of the southern areas, viz., Waimangaroa and Rochfort, have been divided off into levels, viz., high, mid, and low, lettered from A and onwards; while the Orikaka, or eastern portion of the field, shows on working plan as one area, the sections there obtained being likewise numbered.

2. *Area I.*—On working up the Ngakawau River from the coast line, and eastward for a distance of about forty chains, coal is first observed at the Albion Company's tunnel workings (No. 1), showing exposed in an open sectional face on the south side of the river,

which here cuts through the coastal line of range, showing coal 18 feet, of a soft and friable description; dip W. to S.W. 45°. The crops of this seam are traceable southwards, and up a tributary creek (Mine Creek, west bank) for a distance of about nine chains. Further south, from surface indications an alteration in dip shows south, putting on a thick covering of brown clay marl stone, which appears to hold steadily throughout the southern part of the area. Reaching eastward into the area crossing Mine Creek, crops of the same seam of coal are obtained, as showing at Nos. 1, 2, and 3. No. 2, being a drive entered by the Albion Company on to the coal, showing it to be of the same soft description and thickness (18 feet), dip west 45°; while sections Nos. 3 and 3½ are surface outcrops of coal, No. 3½ being a section of the overlying measures a little to the south of above outcrops; dip W. 30°. The measures show to still further ease in dip on reaching further into this area; while reaching E. to S.E. the measures appear to hold steadily, and ease off in dip, and, altering to W. and N.W., hold same till gaining section No. 4, which shows the coal exposed on lower western side of a break marked I., exposing coal 3 feet, of a bright, hard, and clear quality; dip W. to N.W. 170°.

3. From those above indications, I would be inclined to be of opinion that the coal holds steadily through the crop parts and body of this area, of the thickness above given, though I would look for the coal to be of a crushed and bruised description, as the area generally presents that of a slip area; while in the extreme south-east part of the area, which apparently has suffered less from the effects of the slip, the coal would probably improve in structure, though thin, as in section No. 4.

4. The tracing of the continuance of the coal westward, seaward, and to dip of the Albion Company's tunnel workings, lies beyond the limits of surface explorations, the banks of the river slopes being much broken, so that no reliable surface information is to be obtained, the same showing as holding westward till reaching the coast line, the measures here being lost, viz., dip under the tidal drift; while the sectional face at the tunnel workings is favourable to induce the company to prove this mineral by dip workings westward.

5. *Area II. (Crane's Cliff).*—Eastward from the Albion Company's workings, and reaching up the high slopes of Crane's Cliff, showing to be composed of schistose granite topped by coal measures, at an elevation of 500 feet. Overlooking the Albion Company's workings, section No. 5 is obtained, showing coal 18 feet thick, dip W. to S.W.

12°, of an average solidity, more so than that obtained in the slip area below. This coal is traceable along the face of the cliff eastward for about fifteen chains, but appears to thin off in gaining in this direction; while south, along the face of cliff (break 1), the coal appears to hold till gaining section No. 6, there exposing coal 6 feet, dip W. to S.W. 12°, showing indications of pooring, the coal showing here intermixed with bands of shale. Further south along this face, no further coal outcrops are observable, high faces of grit being only seen, as at sections Nos. 7 and 8, dip W. 12°; while eastward, reaching across the area, the same top measures only are noticeable, and appear to hold till reaching Rome's Creek, where the coal shows 6 inches thick, and holds about the same thickness throughout the remaining, or eastern, portion of this area. Extending further southward, and higher into the area, no coal outcrops are observable till reaching under fault 4, section No. 9, showing coal 3 feet 9 inches, dip W. to N.W., of a superior good hard and clear quality. Eastward from the section the coal appears to thin upon nearing to the Round Hill, which here indicates a saddle passing in a N.E. direction; while holding westward, and under fault 4, the coal shows to thicken out to 10 feet. From this westward, top measures afterwards show as holding till gaining section No. 10, in Granity Creek, showing coal mixed with bands of stone 6 feet 6 inches, here evidently giving indications of pooring on reaching this western side of the area. South from above section, and reaching section No. 11, there exposing coal 3 feet, and not bottomed, this coal being clear and hard, and apparently of excellent quality, shows generally an improvement on reaching south into the area.

6. The outcrops of coal I have found in this area, viz., Nos. 5, 6, 9, 10, and 11, being obtained at various scattered points along the area, together with the top measures generally being observable, I would be of opinion that the coal underlies this area, and have therefore marked it as containing coal throughout the greater portion of the area.

7. *Area III.*—Throughout this area, indications show similar to to those obtained in the eastern portion of area 2, viz., a continuance of the coal is traceable as at section No. 13, showing coal 8 feet, dip N. to N.E. 30°; while at No. 12 coal shows 3 feet, dip N.E. 12°, and at No. 14 (south-east corner of the area) exposes coal 5 feet 8 inches, dip W. 10°, intermixed with bands of blaze, those being the only outcrops obtained throughout this area. Generally throughout the top measures appear to bed regular, forming a basin shape, and

generally indicate the coal as holding regularly throughout of good average quality. From those indications I have marked this area as holding coal throughout; the practical proving of this mineral could only be done by rods. The mineral would most probably be reached at no great depth, about 200 feet. Reaching further south, and gaining a height over fault No. 4, which here shows itself to be that of a master fault crossing the field from west to east, the distance of the throw of which, I have not been able to ascertain, it shows to be that of a slanting fault, with a downward throw northwards into areas Nos. 3 and 2.

8. *Area IV.*—The coal shows to hold regular throughout this part of the field; shows to be at first near the fault No. 5, thin; but, upon working back south and west up into the area, till gaining crown of a saddle, observed to pass along the area parallel to the fault. There the coal shows along this line in the numerous creeks cutting this area, varying in thickness from 10 to 53 feet. The measures appear here to be well defined and regular, the greatest dip being N. and N.W. 15°, and the lowest 5°. On reaching further south and west into the area, the measures appear to basin, as the coal shows all but horizontal in the centre of the area. The exact thickness could not be obtained there, only for most part being exposed parts of the seam, 20, 25, and 30 feet, and not bottomed, showing the coal to hold considerable thickness here, reaching further across the area upwards and south. Till reaching the south branch of the Ngakawau, the coal shows along its banks in open sectional faces, showing coal of thicknesses varying from 10 to 30 feet, and continues to expose coal of those thicknesses throughout till reaching under fault No. 9. One seam of coal has only been observed along this area; same appears to be steadily bedded throughout, showing a thinning of the coal to eastward, and a thickening on gaining westward towards centre of basin. The thickness of the coal shown, and variations in dips, may be seen from the accompanying sections.

9. Extending on to the heights of fault 9, which shows to be another master fault passing from west to east, a vertical fault, throws down and north, coal to coal 50 feet, the upper side of which forms

10. *Area V.*,—which shows exposed, along its north boundary, face of fault 9, open sectional faces of coal varying in thickness from 10 to 37 feet, dip N. to N.W. 15° to 8°; while reaching back and south into the area, the coal shows, as seen in the various and

numerous creek beds, as passing steadily through the area, at the same time showing similar indications as those areas lower down the slopes, viz., in thinning upon reaching eastward, holding in considerable body in centre of the area and westward towards the *great sea break;* while reaching into

11. *Area VI.*,—it shows to be that of a continuance of the coal held in area 4, exposing the outcrops of seam held in the same area, which show here on the west side of area, coal holding thicknesses from 3 to 4 feet; while upon working further east, and into the centre of the area, the coal is exposed on the numerous small hillocks, holding in thicknesses from 12 to 18 inches. This point shows to be the north-west heave or arch of the field. Over the crown of same, and to eastward, outcrops of coal are observed on surface, a few inches thick, with an altered dip—N.E. to E.—which followed shows to take on a covering of grits in places. On continuing eastward, the coal continues to thicken, till reaching a denuded face, marked 8, along which the coal shows to hold a thickness of 12 feet, dip E. to N.E. 10°. On working further east and into

12. *Area VII.*,—which shows to be a continuance of area 6, though an area much cut up by denudation, it shows the coal left to hold along and under the denuded face, marked 8, standing as detached island mounds, exposing coal of good quality 12 to 22 feet thick, dip E. to N.E. 10°. Working south into

13. *Area VIII.*—This area shows to be a continuance of the indications obtained in area 6, showing here the coal to hold along the S.W. side of the area, a continuance of the coal held in area 5, showing outcrops exposed in a denuded face, marked 15. On south side of the area, viz., section No. 17, coal 4 feet, dip N.E. 10°; also, westward, in same face, under station T8, coal further shows, holding in thicknesses of 3 feet, 4 feet, 6 feet, and 8 feet, dip N.E. 12°. A portion of this S.W. part of the area I have marked as holding coal. Reaching east and N.E., into the area, the coal would appear to thin, the surface giving indications of denudation, exposing the coal on surface and on crown of the small hillocks 3 inches, 4 inches, 5 inches, and 6 inches in thickness. Same indications hold until gaining the crown, or N.E. arch, of the mount, where it shows the coal on the surface in places. Following further eastward, the coal is observed to make, taking on a covering of grits, and next shows exposed under face 9, near junction of Fly Creek with the Ngakawau; coal 6 feet,

dip E. 10°. The general appearance of the country here allows of a small portion of the area being marked as holding coal, while the central portion of the area shows to be a waste or denuded area. Reaching further south into

14. *High Level A.*—The same seam of coal held in area 5, from indications here obtained, would appear to pass steadily through the greater part of this area, outcrops of coal being obtained along the western side of same face of great sea break, exposing coal 6 feet to 7 feet thick, and is observed to hold steadily along this face south till gaining station T 11. Here a ridge of lower basement rocks appears to stop the exposure of the coal on the outer side of this face. Same ridge appears to encroach on the area upon going south-eastward from this point, station T 11; also south, along the east side of ridge, outcrops of coal are obtained exposed in the numerous creeks cutting the area, as shown at sections Nos. 48, 49, 50, 51, and 52. The coal holds steadily in this direction, holding thicknesses from 6 feet to 25 feet, beds comparatively easy, 5° to 12°, general dip N.E. to E. Further eastward, face No. 16 is met with, passing lengthways (south) along the area, which exposes coal as holding along same for a distance of about two miles, as seen at sections Nos. 42, 45, 47, 51, 54, 56, 58, 59, and 60, proving the coal to hold steadily through this area, at thicknesses varying from 25 feet to 37 feet. In this part of the area I have first observed the holding of a small, or upper, seam (thin), as may be observed at sections Nos. 46, 48, 49, and 54. Holding further eastward from face No. 58, a partially denuded area is met with, showing the remains of coal left in detached island mounds, of thicknesses varying from 5 feet to 25 feet, as found at sections Nos. 1 to 6, 5 feet to 25 feet thick; Nos. 53 and 55, 8 feet to 12 feet thick, the coal generally showing a thinning upon gaining eastward into this part of the area. Further eastward, down the slopes, and gaining

15. *Mid Levels A, B, and C.*—These areas appear to be a continuance of the denuded indications mentioned above, and noted in eastern portion of high level A, though showing the denuding forces to have wholly stripped the coal from off same, here showing, for most part, the same grits on surface as those show for floor of coal held in high level A. Throughout good sections of the strata, 60 feet, 70 feet, and 80 feet, are obtained in the numerous gorgy creeks cutting the areas, all showing the same lower grits from surface downwards as those obtained in the high level, which appears to hold

down to the water level, continuing downwards and east till reaching

16. *Low Levels A, B, and C*,—which extend southward along and under a face marked 12, and eastward, down the slopes, till reaching the base of Mount William Ridge. Under this face, alluded to above, I have obtained coal at No. 28, showing 3 feet thick, dip E. 12°. The general indications around give that of the top measures holding throughout the area till reaching face marked 9. Along the creek banks cutting these areas, good sections are obtained, showing sandstone to hold what would appear to be that overlying the lower seam, general dip E. Same indications hold till reaching under face 9, the area there showing to be a succession of small hillocks, showing to hold principally slate to surface. At the eastern base of these hillocks in that area, Happy Valley, the lower seam of coal is obtained as at sections Nos. 63, 64, and 65, dip W. to S.W. 12°, 12 feet thick, same being traceable across the valley and southward along the base of Mount William Ridge, till observing the putting on of the upper seam, as at sections Nos. 66 and 67; coal 3 feet, dip S. to S.W. 12°. These general indications tend to show that section No. 62, under face No. 12, is that of the upper seam, the probability being that the lower seam holds under the eastern part of areas, and under the sandstone showing along the banks of creek, which assertion may be strengthened by the finding of the lower seam eastward of the slate hillocks. The proving of this eastern part of the area could only be done by rods. Ascending the slopes from mid level C and high level A, the solid hill being principally slate, holding till reaching the table-top area of

17. *High Level B, or Summit of Mount Frederick.*—The slates are here observed to hold a covering of grits holding coal, which shows exposed in the sectional faces around the area, as at sections Nos. 68, 69, 70, 71, and 73, of thicknesses varying from 6 feet to 18 feet, general dip E. to S.E. 10°. In the centre of this area the coal shows a thickness of 20 feet, as at section No. 72, with those sections obtained round the edges of the area, and those showing in the centre of this area, will generally prove the holding of the coal steadily through this area of the thicknesses given in accompanying sections. South from this, and reaching down the south slopes of mount, into

18. *High Level C*,—which shows for greater part to be that of a denuded area, exposing slate on surface, main bearing (cleavage) of which shows to be N.N.W. and S.S.E., which slate continues to show

till midway down the area, in a S.E. direction, where remnant patches of grit are met with, showing coal in faces, as at sections Nos. 83 and 84, coal 20 feet, dip S. 20°, which thins upon reaching E. and S.E. toward face of high level break. On further extending S. and S.W. along this area, the bottom grits are observed to gain in thickness till meeting with a high face, marked on plan S.E. break, as crossing the area from E. to W. and forming southward

19. *High Level D.*—On the heights of this face the coal *is* observed to make, and mainly hold steadily along the west and south-west portion of the area, showing coal in sectional faces overlooking the Waimangaroa Gorge, as in sections Nos. 93 and 94, in thicknesses varying from 20 to 25 feet, dip W. 5°. On working east and south down the slopes through the area, outcrops of coal are obtained in the body of the area, as at sections Nos. 89, 88, 92, and 90, showing a general dip, these sections on the west side of the area S. and S.W., and those on the east side S. to S.E., in thicknesses varying from 5 to 25 feet, lying at 5° to 10°, giving a general indication to bed or basin. On reaching south towards the Waimangaroa River, the coal would appear here to hold steadily along this western portion of the area; improves in thickness upon gaining south; also here is observed the putting on of the upper seam though thin (see sections); while gaining eastward a denuded part of the area is met with, which holds east till reaching the high level break, the lower side of which forms

20. *Low Level D.*—This area holds along the lower slopes of Mount Frederick, skirting the base of Mount William Ridge. The northern extremity of this area shows to be a continuance of low level C, holding a continuance of the coal traced through Happy Valley, exposing, as at section No. 31, coal 6 inches, dip S.E. 10°. Holding in a southerly direction along the area, the coal would appear to bed, holding and exposing the two seams (upper and lower), as at sections Nos. 75 and 76, dip S. to S.E. 12°; afterwards covered by brown marlstone holding clay-band nodules of ironstone. On reaching south, general indications show of forming a trough or basin along the base of Mount William Ridge, the coal (lower seam) appearing to thicken upon reaching south along this trough area, as at sections Nos. 78, 77, 80, and 82. The two seams of coal appear to be bedded steadily through this area, in thicknesses as given in above sections. Eastward, and reaching into

21. *Mid Level D*,—which shows to hold the outcrops of the coal

bedded in this lower area (low level D), those outcrops (Nos. 80 and 49) contained coal 4 and 18 feet thick, dip S. to S.E., shows a slight thinning upon gaining and reaching under high level break, though to all appearance the coal beds steadily south into

22. *Mid Level E*,—which shows to be a continuance of the basin-shaped area before given, and likewise of the coal passing from high level D, here showing faces of coal exposed along the south bank of the River Waimangaroa, as at sections Nos. 97, 96, and 95, showing a thickness (lower seam) at No. 95, 40 feet, dip S. to S.E. 8°. The coal here shows at water level, and at this point would judge to be about the centre of the basin. No sections are obtained further eastward in this area, but would look for the coal to thin upon gaining in this direction, being towards and under the heights of Mount William, as shown at section No. 97, an alteration in dip S. to S.W. Westward from section No. 78, further sections show Nos. 100, 99, and 98, showing here a thinning down to 10 feet, and of further thinning on reaching westward along the edge of the Waimangaroa Gorge, north side of the Mount Rochfort Plateau. South along the area, the measures are observed to hold an altered dip, N. to N.W., and hold at same till reaching the south-west shoulder of Mount William, which shows to be composed of slate crossing the area south-west, which would appear to cut the coal out till crossing same, and reaching

23. *Coalbrook Dale Area, Mount Rochfort*,—the S.W. shoulder here forming the northern side of this area. At first, upon working off this shoulder, the coal shows thin, but upon gaining in a S. and E. direction a basin-shaped area would appear to form, showing along the N.E. and E. boundary or face of Cascade break coal in sectional faces, as at Nos. 117 and 123, exposing the two seams of coal (upper and lower), the upper holding a thickness of 5 feet. This seam is only obtainable in a few preserved places throughout the area, while the lower seam shows a thickness of 18 feet, and appears to underlie the greater part of the area, showing upon leaving the eastern face, Cascade break, the coal to bed (basin). Upon reaching westward along the area, the coal apparently turns or alters in dip, also shows a thinning upon gaining in this direction, as at sections Nos. 112, 115, 121, 113, and 111, indicating a gradual thinning, and of afterwards running out to surface. Outcrops show on slate ridge near centre of Mount Rochfort Plateau. Reaching further along the area, south, into

24. *High Level (Rochfort).*—This area shows to be a continuance of the coal area basin of Coalbrook Dale; shows the coal here to be the southern edge of that basin. The coal here at first shows to hold steadily upon making into the area, as shown along the eastern side of area under base of Mount Rochfort Ridge, as at section No. 125. The lower seam appears to hold a uniform thickness, 18 feet, dip N.E. On holding higher up the slopes of mount the coal would appear to poor and thin, as at section No. 126, showing blaze 20 feet, mixed with thin bands of coal varying from 6 inches to 1 foot, gradually pooring till reaching under the summit of the mount. While extending W. and N.W. from the eastern side, the upper seam shows in places, as at sections Nos. 129, 130, 131, 127, and 133, there showing the coal thin, 12 inches to 6 inches, dip N. to N.E. and N.W. Holding further down the slopes till reaching the River Whareatea, the lower seam here shows, as at section 133, 6 feet, with an irregular dip, here showing a thinning of this lower seam upon passing westward through the area, being somewhat similar to that of the Coalbrook Dale area. On reaching westward into

25. *Plateau, Mount Rochfort*,—the same seam is here observed on the north-west or west side of the Whareatea River (section 134), which continues to hold westward till reaching a slate belt which shows on surface centre of plateau, this being the same belt referred to in the W. and S.W. crops of the Coalbrook Dale area. The appearance generally throughout this area presents that of a denuded area of top measures, as in places remnants of coal shows in south part of area, apparently soft and friable, and holds so in places only till under the summit of mount, the same indications showing westward till gaining the western edge of plateau, which here shows a break hitherto named western break, probably a continuance of the great sea break to north. Same break holds southward from here along the slopes, crossing the crest of the mount, about fifty chains south from summit. On this face a section of coal is obtained (No. 135), a little to south of the bore-hole, showing bruised coal 3 feet, dip W. 15°. The lower part of this section (No. 135) will compare somewhat similar to section No. 136, facing the Waimangaroa Gorge, showing thin bands of coal varying from 6 inches to 12 inches, which sections could be taken as the sequence proper to this western face of plateau. Eastward from section No. 136, and continuing up the river, the coal is traceable along the cliff till making into mid level E, the coal gradually thickening from 6 inches to 10 feet on going in this direction; shows to be here of an

average quality, though I should be of opinion that this coal if driven into would not hold for any distance into plateau beyond a few chains, as the slate before referred to shows a few chains south-east on surface.

26. Southwards along the face of break from section No. 135, where near crest of mount, a small preserved area shows a section somewhat similar to that previously given (No. 107), showing coal mixed with bands of blaze, and holding the general indications of pooring. Descending from these heights seaward into the

27. *Western Slip Area.*—Upon reaching the south bank of the Waimangaroa River, at Roche's mine, a descent equivalent to 1,000 feet (No. 147), a seam of crushed blind coal, 18 feet thick, dip W. 40°, shows, into which has been entered a drive for about 4 chains, showing the coal of the same quality and holding the same high angle of dip up to face. To the dip of this drive, about 70 feet, a second or lower drive has cut coal, apparently of same soft quality, showing a thickness of 8 feet, dip 60°, thus showing a thinning and higher angle of dip. On the north bank of the river the same seam shows in a drive known as Sims', or Mullholland's (No. 148), here cutting the coal of the same quality, thickness, and dip N.W. 40°. From this and northward, clay marlstone is observed to hold steadily along this line of low country to Nikau Creek (or Deep Creek), overlying the grit measures, all holding a general dip W. to N.W. 35° to 60°, and showing to the eastward, close under line of break, outcrops of coal, as on Organ's Spur. To north, sections Nos. 150, 151, 152, and 149, holding coal 20 feet, dip W. to N.W. 30°; while along same line, to south of Sims' Spur, the coal on surface is of the same soft quality as that obtained in Sims' and also Roche's drives, near the river dip. Those outcrops being obtained from the two extremities of the area, together with the fact that the measures hold steadily throughout the area, though at high angles, indicate that the coal holds regular along this area from the Waimangaroa north to Nikau Creek, of the quality and thickness above given. The coal may reasonably be expected to improve on gaining under the weight of Sims' Spur, and also to show outcrops in places along the line of slip country north to the Ngakawau coal, which, from general indications, I consider to be a continuance of this slip area.

28. Reaching the heights of break, on Sims' Spur a small area of coal is met with, which I have laid bare by grit pits and trenches. Along the edge of Waimangaroa Gorge, as at sections Nos. 153, 154,

155, and 156, holding coal 16 feet, followed by shale band and coal 12 feet, general dip N.W. 20°. This coal where unearthed shows to be of average good quality, though soft, and if driven into would tend to improve. Same indications hold till midway up the spur, though pooring towards a denuded area.

29. On the same line and height on Organ's Spur, slates only are exposed on surface, while the remaining heights of both spurs continue to show remnant masses of grit and crushed coal, till gaining under the western face of plateau heights of Mount Frederick, or high level D.

30. From the Waimangaroa, and southward from Roche's drive, outcrops of coal are obtained throughout the area, as at sections Nos. 146, 123, 126, 142, and 138, showing bruised coal from 3 feet to 10 feet thick, average of dip being about 40°, generally indicating a thinning upon going south along the area. In this part of the area I have found difficulty in obtaining reliable information, the surface and creeks being mostly covered and filled with broken *débris* fallen from the plateau heights.

31. Crossing the Whareatea River, and southward under the break, passing what is termed the Quarry, Hatter's Terrace, Rochfort Terrace, Giles's Terrace, Caledonian Terrace, and south to the Buller River, shows a continuous area of broken masses of grits, and in a few places irregular small patches of dust or sooty coal of an unmarketable quality, showing the southern part of slopes of Mount Rochfort, from crown to base, so far as known from surface explorations, to be devoid of coal of any value.

32. *Crest and East Side of Mount Rochfort.*—From the Buller River north till reaching under the slopes of Mount William, shows to be an escarpment or break, termed the Cascade Break, holding the entire length of the mount, with an all but perpendicular face varying in height from 1,000 feet to 2,000 feet. The lower bed rocks are conglomerates and coarse hard grits, resembling in places sandstone breccia, followed by slate schist and, in places, granite. The country eastward from this break appears to be a succession of small hills and rugged ridges, wholly slate and granite to surface, which country appears to hold eastward till reaching the Buller River, though in the north-east corner of this area, and under the Cascade Break, which here forms the east side of the Coalbrook Dale area, a small remnant and basin-shaped area shows under the south-west and south-east shoulders of Mount William, holding coal (lower seam) along the west banks of Todea Creek,

and also along the east bank of the creek, in a small shelf; to the south-east shoulder of Mount William, for a length of about 30 chains, where it is cut off by the nearing in of the precipitous slopes of sidling. The coal is first obtained in the south part of this area, and shows thin, but gaining northwards, till, at section No. 207, it exposes coal 25 feet, dip N. to N.E. 8°, and further followed by sections Nos. 140 and 139; coal 30 feet, dip N. to N.E. Here a small fault is observed crossing the area from east to west, the hold being under the downthrow north 20 feet. The coal shows at No. 166, 20 feet thick, horizontal; and further north sections Nos. 161, 163, 164, 159, and 160, show thicknesses varying from 40 feet to 3 feet, with a N. to N.E. dip 15° to 5°, showing a general thinning upon gaining north and under the south-west shoulder of Mount William and head of Cascade Break. Extending westward, across the area towards the Cascade Break, the central part of this basin area coal is traced to hold till meeting with what would appear to be a second or inner break, showing the coal to hold throughout the area a breadth under break of about 5 chains, and of the thicknesses given in sections. The south part of the area shows to hold coal solid till midway west in the area, afterwards showing loose broken grit and bruised coal, holding till under the Cascade Break, which break passes south along the western side of this area, the whole showing to be a slip or remnant from the Coalbrook Dale basin area above, dropped eastward at the two extremities 400 feet to 450 feet, followed by a second or inner drop (central portion of area only) of further 400 feet. Throughout this area the coal shows to be of the same good sound quality, as that found in the Coalbrook Dale area; continuing northward and reaching up the heights of

33. *Mount William Ridge*, which holds slate along it west slopes, though topped by grit measures in places, overlooking the Coalbrook Dale area and south-east and eastern slopes of Mount Frederick, and marked on plan as "Great East Fault." On the summit of this mount a coal area shows, exposing the two seams of coal, the upper seam thin throughout, and the lower seam thick, holding round summit 4 feet, 3 feet, and 2 feet, but thickening upon gaining north, as shown in sections Nos. 107, 104, 108, 105, 106, and 103, varying from 6 feet to 40 feet. It is similar in structure and quality to that obtained throughout Coalbrook Dale and area mid level E.

34. Northward, along the summit of the ridge, the crown shows to be a continuous denuded length, showing mainly slate to surface,

though capped in places with small remnant patches of grit underlaid by soft thin coal apparently worthless; the same continuous indications are seen till reaching section No. 101, where a small area of friable coal 6 feet, dip S.W. 10° is preserved; while north from this a succession of denuded areas occur similar to that before mentioned, which holds till reaching a gorge of the Ngakawau River, or east side of area No. 8, which generally shows this ridge crown to be a waste, while the

35. *East Slopes of Mount William Ridge*—have been partially explored, viz., downwards, along slopes, from a point crossing ridge bearing E.N.E. from the summit of Mount Frederick, hitherto termed the divide (meaning the divide of the waters flowing south towards the Buller River, and those flowing north towards the Ngakawau River). From the alteration of dips along the breadth of the field here on both sides of this line, northerly and southerly, it would appear to form that of the central arch or heave of the field. These slopes continue to show a continuance of the denuded area mentioned, as holding along crown of ridge, viz., in small remnant patches. Coal appears to hold only in a few hillocks along the curved slopes, varying in thickness from 1 foot to 3 feet, and in one place it has been observed to be 7 feet. From the indications obtained in the creeks and hollows, it shows to rest upon schist. This slope evidently holds the same indications lengthways, from the divide north and down, till meeting with a break, showing coarse hard grit and schist on face, which passes along the base of the slopes in a south to north direction, the low ground of which forms a valley or basin-shaped area extending eastward and north, named the

36. *Tio (Orikaka) Valley.*—Coal has been traced to underlie the greater part of this valley, viz., from a point where the valley is crossed by the Orikaka River, and northward, showing at first that of a denuded area, exposing bottom coarse grits on surface; and northwards shows small preserved mounds holding coal, as at sections Nos. 172 and 183, dip N.W. 8°, same holding till reaching the divide, there showing coal outcrops, two seams holding along its length, from a point under base of ridge (break) and across the valley west to east, as at sections Nos. 176, 179, 171, 180, and 173, in thicknesses varying from 25 feet to 8 feet shown; also north, as at Nos. 1 and 11½, outcrops of the upper seam are obtained, 6 feet. The measures here appear to undulate, causing variations in dip, viz., from N. to N.E. to N. to N.W., but show generally a northerly dip, and bedding under the area northward.

37. Along the west side of this valley, under base wall of ridge, coal has been traced north, showing at section No. 177, coal (lower seam) on edge, and to apparently butt against the base wall of ridge (or break), coarse hard grit; and north, though east from under break, a few chains, as at section No. 6, coal shows lower seam 10 feet, dip E. 8°. Further outcrops show, as at section No. 11½, and at section No. 175, under the west base of an island hill (upper seam), thickness 1 foot, dip E. 50°. On crossing the valley the sandstone is observed to bed all but horizontal, with a slight dip north, and further altering eastward to N. to N.W., there lost by a covering of brown clay marl, which holds till reaching the east side of the area, here observed to rest upon schist, overlapping the coal measures, which otherwise would have been expected to have cropped about this point.

38. From the outcrops obtained along this area and line of divide, the width of the area, the general dip at south end being north, on west side east, together with the measures (upper), fossil sandstone showing all but horizontal, and of further altering to N. to N.W., gives general surface indications of a basin-shaped coal area, and of the two seams underlying the southern part of this valley, and of holding north till within close proximity of a long terrace about four miles north from divide, which there shows to hold marls the whole width of the area, from W. to E.

39. Northwards from this terrace, along an undulating country, a continuance of the marls holds steadily, capped with a covering of alluvial wash, till reaching the shed (T 150), falling northward towards the Mokihinui River. In this space my labours have been necessarily limited to a few creek beds, resulting in obtaining sections only on the extreme west and east sides of the area; that obtained on the west side, under base of Mount William Ridge, section No. 184, shows coal mixed with blaze 2 feet, dip E. to N.E. 5°. In crossing the area from west to east, about mid-way has been observed in the creek beds a heave, exposing the schist resting against the marl—a probable ridge caused by the undulating nature of the ground; same ridge passes from S. to N. through the area. Eastward from this, marls hold till reaching the extreme eastern side of the area, base of the Lyell Range, as at section No. 16, showing slate to crop from under the marls. From the indications here obtained, I should generally show the thinning of the coal upon going north from the long terrace towards this area, and would also surmise this remaining space north to be a waste area till reaching the crown of the *Mokihinui Sheet*. From this, on

descending to the northwards, it shows to be a denuded area, and to hold lower grits to surface, till reaching mid-way the slopes (peg 185 of M. N. Line) at which point surface indications would appear to indicate a break as passing along the slopes about E.S.E. and W.N.W. Under the break, in the low ground to north, marls are observed, underlaid by the upper grit measures, and apparently hold steadily to Page's Creek (peg No. 191, M. N. Line), which bottoms the measures, showing schist at water level. The undulating measures here hold along the slopes and up the creek E. to S.E., exposing a sectional face of coal about 90 chains up No. 185, showing coal 8 feet, dip W. to N.W. 5°. From this, continuing north and to dip of measures till gaining Parenga (Coal) Creek (peg No. 199, M. N. Line), up and eastward along this creek, coal shows exposed along its banks in high faces, as shown at section No. 186, dip N. to N.E. 10°. Section No. 187 shows coal, dip N. 10°; No. 188, dip E. 18°. The full thickness of the coal I could not ascertain here, but that exposed above water level in the above three sections given (Nos. 186, 187, and 188) shows 18 feet, 10 feet, and 2 feet shown. Continuing further east till reaching the base of the main range, the schist is observed to crop from under the marls.

40. From this north, till reaching the Mokihinui River south bank, marls appear to hold the entire distance, showing here also, at the base of the range (Welcome Bay), the marl to overlap the schist; while westward, down stream, the measures hold in an undulating depressed form, crossing the mouths of Putoti Creek, Parenga (Coal) Creek, also that of Page's Creek, here showing grit measures exposing coal (sections Nos. 189 and 190) 8 feet, dip N.W. 8°. This is known as Seaton and Co.'s workings. Here a drive has been entered eastward, showing the coal to poor and thin. Up this creek, southward and along the east banks, crops of the coal are seen thinning, as exposed at section No. 189, 18 inches; while westward, on crossing Page's Creek, the coal evidently holds in the same undulating form, till reaching the east slopes and crown of the coast range, as shown at sections Nos. 191, 192, and 194, showing, in one place (Nos. 191 and 192), coal 4 feet; and in the remaining parts of the area the coal has been observed loose in the beds of the western tributaries of Page's Creek, no face being exposed.

41. The limited information I have obtained, mainly extending along the apparent strike of the measures, warrants me asserting that an undulated basin area of coal (one seam only seen) underlies

this area, viz., from the east slopes of coast range extending eastward along and under an apparent dislocation (peg 185, M. N. Line), till gaining within close proximity of the base of main range, of the thicknesses shown in sections. Samples of this coal have already been forwarded.

42. The coal obtained in centre of the area is of good structure, and great thickness, 18 feet being visible; but, upon reaching the west side of the area, it apparently thins down to 4 feet, and becomes intermixed with bands of shale.

43. On the north side of the Mokihinui River, although I have not extended my labours there, yet from general indications showing along the banks of the river, the coal area above mentioned would appear to further hold north and basin deep, probably under the range which I am informed is composed of white limestone similar to that overlying the Grey Coal Field.

REMARKS.

44. The table-top summit of Mount Frederick would appear to show as the central area of this field, from which the central axis would probably verge, as at and from this point an apparent saddle-backed ridge passes from north to south of the field, holding on crown (high level B) a remnant area of coal, exposing, by denudation, basement rocks, slate on the four sides of the area.

45. On descending northwards down the slopes, about midway two master faults cut the field from east to west, the highest on the heights (No. 9) shows to fault vertical, with a downthrow to north of 50 feet, exposing along its face (upper side) coal varying in thickness from 47 feet to 20 feet. In the downthrow area (No. 4), the measures basin (synclinal form), showing coal throughout in thicknesses varying from 53 feet to 20 feet. In the lower or northern side of this area, the second or lower master fault is met with (No. 5), which shows to be a slanting fault, with an underlie under downthrow north. The extent of the throw here I could not ascertain, it being a work to be determined by future mining enterprise, but would judge it to exceed 200 feet. Holding lower down the slopes, the measures again hold an anticlinal curve form, holding coal, as shown, 4 feet to 8 feet, as at sections Nos. 58, 31½, and 31; and, upon reaching north, till gaining face of Crane's Cliff, shows coal in face No. 29, 18 feet. The face of this cliff here indicates a break (a probable continuance of great sea or western break), at 800 feet descent. Near sea level, at the base of the cliff, outcrops of blind coal (crushed) 18 feet thick show, holding

a high angle of dip W. 40°, showing faulted measures, generally indicating this lower area to be the remnant broken from the heights of Crane's Cliff above.

46. The easterly and southerly slopes of same mount (Frederick) indicate the measures and coal holding an anticlinal curve form, though east, about midway down the slopes from high level break and downwards, they form a synclinal curve (or trough area of coal), holding along the west base of Mount William ridge and southwards, afterwards forming a basin-shaped area in a low though upland valley confined by the slopes of the three mounts—Mount Frederick to north, Mount William to east, and Mount Rochfort to south—and named on plan "Mid Level E," and Coalbrook Dale, all showing holding the two seams of coal, the lower varying in thickness from 11 feet to 40 feet. In the former (mid level E) appears to bed well through the area, and in the latter (Coalbrook Dale) appears to bed in an undulating form, and thins and poors upon reaching up the north slopes of Mount Rochfort.

47. The westward or seaward slopes shows to be denuded in parts on the extreme heights, and on descending apparently is cut by an escarpment passing under summit (Mount Frederick) northwards, towards and to the Ngakawau, Crane's Cliff; also southwards, holding about midway along the slopes of this and that of Mount Rochfort, crossing crest of mount about 50 chains south of its summit. To the westward, and under this escarpment, is the area referred to as western slip area, showing to hold a waste area from Buller River north to the Whareatea, and of bruised blind coal, holding from the latter river to the Waimangaroa, and northwards towards the Ngakawau River, apparently dips at high angles (W. 35° to 40°) its entire distance.

48. The east side of the field, along the crest of Mount Rochfort and ridge, shows likewise to be cut by an escarpment passing north from Buller River, till under the southern slopes of Mount William, showing many outliers along the line. The country under and to eastward shows as being a denuded, rugged, and waste area, holding basement rocks (slate) to surface, though at its northern extremity holds a small preserved remnant basin-shaped coal area under the summit of Mount William, confined by the narrows of the S.W. and S.E. shoulder of same mount, named on plan "Todea area," here holding coal (lower seam) 3 feet to 40 feet thick. General indications show this to be a remnant broken from the Coalbrook Dale basin or plateau heights. Continuing from this northwards, and gaining the heights of Mount William and William Ridge, the summit here shows to hold a small

table-top area of coal, the two seams, the lower varying in thickness from 4 feet to 40 feet, exposed here in vertical faces on three sides of the area. The S.W. and W. face overlooks Coalbrook Dale and plateau, upland valley. The ridge holds northwards, overlooks the east slopes of Mount Frederick (a doubt exists as to whether this ridge forms a fault or a break), the length on height of this ridge shows to be a denuded area, holding generally slate to surface, and, in places, denuded and detached masses of grit holding like remnants of blind coal.

49. Down the east slopes of this ridge a continuance of the denuded area holds down and along its curved slopes, showing in places remnant detached masses of coal as holding in places till reaching its base. The Tio (Orikaka) Valley here shows outcrops along the line of divide of the waters of the Orikaka and Ngakawau, which divide crosses the valley from W. to E., forming what would appear to be the central arch of this part of the field. Along the west side of this valley coal outcrops show, dip E., generally indicating a basin area of coal as holding northwards, and afterwards thinning out on reaching into a hollow undulating country to north, showing same till reaching the Mokihinui sheet. North from this the coal forms, showing to be an undulating basin, which holds till reaching the Mokihinui River, south bank, the furthest north point I have explored up to, though general indications along the river bank show the coal to dip deep to the north, under a range known seaward as the Remarkables, said to be composed of limestone.

50. Two seams of coal occur in the Buller Coal Field, the upper, though thin seam, in a few instances has been observed 3 feet, and in one section (Coalbrook Dale) shows 5 feet thick, while the general thickness is 12 inches. The greater portions of the upper measures throughout this field have suffered by denudation, which apparently has left small remnants in places, so that this seam being thin, rock bound roof and floor, and of small remaining extent, is not likely to add to the tonnage of the field practically as a workable seam, but may be worthy of mention for scientific record.

51. The second, or lower and practicably workable seam, though showing to be eroded off in a few minor places, yet generally holds continuously well bedded under the greater portion of the field, in outcrop thicknesses and dip varying on the slopes north 53 feet to 20 feet, 2° to 15°; east and south, 18 feet to 40 feet, 5° to 15°; and west slip area, 18 feet, 30° to 40°. Attention may here be

drawn to a doubt that exists, and may hold good, that the remnant coal area on summit is that of the upper seam. If so, the field would show the thick coal on the north slopes to be that of the upper seam thickened, and thinning towards E. and S.E., and from the ridge. This doubt may be strengthened by the lower seam in the south part of the field differing in structure and quality from that of the north thick coal, which may indicate a lower seam underlying the areas (a probable continuance of the Coalbrook Dale lower seam), but this only could practically be proven by rods, and, if with satisfactory results, would greatly add to the present approximate tonnage of the field.

52. The coal underlying the field appears to vary in structure; and having burnt the coal in open hearths in various parts of the field, I may say it also varies in quality. That obtained on the north slopes summit, upper S.E. and S. slopes of Mount Frederick, shows to be a caking or strong bituminous coal, whole in structure in the face, but, when handled, light and tender in the mass, the lower part of the seam being harder than that of the upper. It throws out in burning a strong heat, swells, cakes, and runs together. In the east, south-east, and south slopes of Mounts Frederick and William, Coalbrook Dale, Todea area, and northern slopes of Mount Rochfort, the coal (lower seam) appears to resemble somewhat splint or cannel coal, being hard, compact, and clear in structure, has a jet-like appearance, burns free and open, with a candle-like flame, cakes slightly, gives out a great and lasting heat; while the coal on the west slopes of Mount Frederick and Rochfort slip area resembles a blind coal in structure, but would appear to be a bituminous coal similar to that obtained on the north slopes of Mount Frederick, though bruised; it swells and cakes freely in burning, though it burns with a dull flame. The coal obtained in the Tio or Orikaka Valley shows similar to that of the east slopes of Mount Frederick; that obtained along the Mokihinui sheet shows sound in structure, but of inferior quality to any yet obtained, as may be seen from samples forwarded.

53. Timber suitable for mining purposes, along the west slopes of Mounts Frederick and Rochfort, also east slopes of Mount Rochfort (Todea area), and Tio (Orikaka) Valley, is to be obtained in abundance for the requirements of these areas; but on the heights of plateau such is not at hand, and mining workings here will depend upon supplies from those lower areas.

54. For the working of the mineral, facilities generally offer throughout the field for tunnel workings entered most probably in the open

sectional coal faces along the areas, which, together with the coal, holding an excellent roof and floor; also, generally an easy dip should allow of a working being opened up at a small cost.

55. As mentioned in previous reports during progress of my explorations, as apparent accessible routes for forming ways for the carriage of the mineral from those heights to the railway, I now only briefly repeat here, viz., from the north slopes of Mount Frederick, for a permanent way along the east side of coast range, leading to the Ngakawau River; or by light self-acting tram down the slopes of Granity Creek. The areas on the south slopes of Mount Frederick, by self-acting tram down Sims' Spur to the Waimangaroa River; that of Coalbrook Dale, by across plateau to western face, and hence down Roche's Spur, by self-acting tram, to the railway; that of the Todea area could be delivered on to plateau by trams wrought by stationary engines fixed on top Coalbrook Dale, and further delivered to the railway by the Coalbrook Dale line of tram.

Detailed Sections of the Coal Measures as Plotted on the Working Plans of Buller Coal Field.

Area I.

		Ft.	in.
No. 1	Marl		
	Soft brown sandstone		
	Fine freestone - - - - - - -	20	0
	Fine sandy grit - - - - - - -	8	0
	COAL - - - - - - - - - -	18	0
	Shale - - - - - - - - - -	1	0
		47	0
	Dip, W. to S.W. 40°. Resting upon coarse hard grit.		

		Ft.	in.
No. 2	Small drive entered on the coal, north side of Mine Creek		
	COAL - - - - - - - - - -	18	0
	Dip, W. 40°		

No. 3—Outcrop of coal showing on surface; continuance of No. 6.

		Ft.	in.	Ft.	in.
No. 4	Soft sandstone - - - - - -			8	0
	Soft sandstone, with dark partings - -			1	0
	COAL - - - - - - - - -	2	4		
	Shale bands - - - - - - - -	0	8		
				3	0
				12	0
	Dip, W. to N.W. 17°.				

No. 3½—Marls showing to overlie grit measures in creek bed.

No. 3—Outcrops of coal on surface; no thickness obtained. Dip, W.

No. 3—Surface outcrops of coal; same as No. 3.

AREA II.

	Face of Crane's Cliff.	Ft.	in.
No. 5	Surface		
	Grit, fine	12	0
	COAL	18	0
		30	0
	Dip, W. to S.W. 10°.		

		Ft.	in.
No. 6	Fine grit stone	3	0
	COAL	6	0
		9	0
	Dip, W. to S.W. 12°.		

	Ft.	in.	Ft.	in.
No. 7—High face of upper sandy grits			70	0

No. 8—Same as No. 7.

		Ft.	in.	Ft.	in.
No. 9	Soft grit stone			4	0
	Soft sandstone, with dark partings			1	0
	COAL	3	0		
	Blaze	0	9		
				3	9
				8	9
	Dip, W. to S. 20°.				

		Ft.	in.	Ft.	in.
No. 10	Soft sandy grit			60	0
	Blaze, mixed with thin bands of coal	3	0		
	COAL	0	6		
				3	6
	Soft sandstone, mixed with blaze and coal			6	6
	Coarse hard grit			18	0
	Schist to water level			24	0
				112	0
	Dip, W. 8°.				

AREA III.

		Ft.	in.	Ft.	in.
No. 12	Surface				
	Soft grit			24	0
	COAL	1	0		
	Blaze	2	0		
				3	0
				27	0
	Dip, N. to N.E. 12°.				

		Ft.	in.
No. 13	Fine red to yellowish sandstone	40	0
	Soft sandstone, with dark partings	3	0
	Fine grit	10	0
	COAL	6	0
		59	0
	Dip, N. to N. E. 3°.		

		Ft.	in.	Ft.	in.
No. 14	Soft grit			18	0
	COAL	1	0		
	Blaze band	1	10		
	COAL	0	6		
	Blaze band	0	4		
	COAL	2	0		
				5	8
				23	8
	Dip, S.E. 10°.				

AREA IV.

		Ft.	in.	Ft.	in.
No. 15	Soft sandy grit			32	0
	Soft sandstone, with dark partings			2	0
	COAL	3	0		
	Blaze	7	0		
				10	0
				44	0
	Dip, W. 17°.				

		Ft.	in.
No. 16	Soft sandstone grit	18	0
	Fine sandstone	1	0
	COAL	12	0
		31	0
	Dip, N.E. to N. 8°.		

		Ft.	in.
No. 17	Surface		
	Fine grit	12	0
	Soft sandstone	20	0
	COAL shown	20	0
		52	0
	Dip, W. 12°.		

		Ft.	in.
No. 18	Fine grit	8	0
	Fine sandstone	18	0
	COAL shown	10	0
		36	0
	Dip, W.		

No. 19—Roof of coal only showing on surface.

No. 20—COAL exposed in the bed of the creek.

		Ft.	in.
No. 21	Soft brown sandstone	2	0
	COAL	53	3
		55	0

Dip, N.W. to W. 5°.

No. 22—COAL showing in bed of Granity Creek. Dip E.

No. 23—Same as No. 22.

No. 24—Same as Nos. 22 and 23. Dip, E. to S.E. 10°.

		Ft.	in.
No. 25	Surface		
	Broken grit and sandstone	12	0
	COAL (crushed)	18	0
		30	0

		Ft.	in.
No. 26	Surface		
	Fine quartz grit	12	0
	Soft brown sandstone	40	0
	Soft laminated sandstone	2	0
	COAL	10	0
	Shale	2	0
		66	0

Dip, N. 8°.

		Ft.	in.
No. 27	Surface		
	Soft quartz grit	8	0
	Soft brown sandstone	12	0
	Soft shale stone	3	0
	COAL	8	0
	Shale	2	0
		33	0

Dip, W. to N.W. 5°.

AREA V.

		Ft.	in.
No. 28	Soft grit stone	8	0
	Soft brown sandstone	12	0
	COAL	36	0
		56	0

Dip, N. to N.W. 8°.

		Ft.	in.
No. 29	Surface		
	Soft quartz grit	6	0
	Soft brown sandstone	8	0
	COAL	30	0
		44	0

Dip, N. to N.W. 8°.

		Ft.	in.
No. 30	Soft quartz grit	8	0
	Soft brown sandstone	8	0
	COAL	27	0
		43	0
	Dip, N. to N.W. 8°.		

		Ft.	in.
No. 31	—COAL	12	0
	Dip, N. to N.W. 8°.		

		Ft.	in.
No. 32	—COAL	8	0
	Dip, N. to N.W. 8°.		

		Ft.	in.
No. 33	—COAL	8	0
	Dip, E. to N.E. 12°.		

		Ft.	in.
No. 34	Sandy grit	12	0
	COAL	37	0
		49	0
	Dip, E. to N.E. 15°.		

AREA VII.

		Ft.	in.
No. 35	Soft quartz grit	4	0
	Soft sandstone	18	0
	COAL	20	0
		42	0
	Dip, E. to N.E. 5°.		

		Ft.	in.
No. 36	Soft quartz grit	8	0
	Soft sandstone	24	0
	COAL	11	0
		43	0
	Dip, E. to N.E. 5°.		

AREA VIII.

		Ft.	in.
No. 37	Soft grit	2	0
	COAL	4	0
		6	0
	Dip, N.E. 10°.		

No. 38—Other sections marked as coal-holding thicknesses, varying from 3, 4, 6, and 8 feet. Dip, N.E.

HIGH LEVEL A.

		Ft.	in.
No. 39	—COAL	8	0
	Dip, E. to N.E.		

		Ft.	in.
No. 40	—COAL	5	0
	Dip, E. to N.E.		

No. 41—COAL; roof only seen. Dip, E. to N.E.

	Ft.	in.
No. 42—COAL	25	0

Dip, E. to N.E. 12°.

	Ft.	in.
No. 43—COAL	25	0

Dip, E. to N.E.

No. 44—COAL. Dip, E. to N.E.

		Ft.	in.
No. 45	Surface		
	Fine quartz grit	20	0
	Soft sandstone	10	0
	Blaze	6	0
	COAL	25	0
	Shale	4	0
		65	0

Dip, E. to N.E., 15°.

		Ft.	in.
No. 46	Surface		
	COAL	0	6
	Sandstone	2	0
	Fine grit	5	0
	Soft sandstone	6	0
	Blaze	3	0
	COAL	12	0
	Shale		
		31	6

Dip, N.E. 12°; resting upon coarse hard grit.

		Ft.	in.
No. 47	Surface		
	Fine quartz grit	20	0
	Soft sandstone	10	0
	Blaze	3	0
	COAL	6	0
	Shale		
		53	0

Dip, W. 5°; resting upon coarse quartz grit.

		Ft.	in.
Nos. 48 and 49	COAL and blaze	1	0
	Soft sandstone	3	0
	Fine grit	10	0
	Soft red sandstone	6	0
	Blaze	3	0
	COAL	25	0
	Shale	4	0
		52	0

Dip, S.E. 10°; resting upon hard coarse grit.

No. 50—COAL showing only in bed of creek.

Nos. 51 and 52 } COAL showing in centre of area in creek bed.

		Ft.	in.
No. 53	Fine grit	10	0
	Soft sandstone	5	0
	Blaze	4	0
	COAL	12	0
	Shale	6	0
		37	0

Dip, S. 10°; resting upon coarse grit.

		Ft.	in.	Ft.	in.
No. 54	Fine quartz grits			5	0
	Soft red sandstone, with shaly partings			5	0
	Blaze	0	6		
	COAL	1	0		
	Shale	0	6		
				2	0
	Soft sandstone			25	0
	Blaze			4	0
	COAL			37	0
	Shale			5	0
				83	0

Dip, S. to S.E. 8°; resting upon coarse grit.

		Ft.	in.
No. 55	Fine grit	8	0
	Soft sandstone	3	0
	Blaze	3	0
	COAL	8	0
	Shale	4	0
		27	0

Dip, S. 10°.

		Ft.	in.
No. 56	No section obtained.		
	COAL	10	0

	Ft.	in.
No. 57—Part of seam exposed	5	0

		Ft.	in.	Ft.	in.
No. 58	COAL	0	6		
	Shale	1	0		
	Soft sandstone	2	6		
				4	0
	Fine grit			10	0
	Soft red sandstone			5	0
	Blaze			2	0
	COAL			32	0
	Blaze			4	0
				57	0

Dip,

Nos. 59 and 60 — COAL, 5 and 8 feet, shown. No sections obtained.

		Ft.	in.
No. 61	Fine grit	3	0
	Soft sandstone	2	0
	Blaze	3	0
	COAL	8	0
	Shale blaze	4	0
		20	0

Dip, S. 10°; resting upon hard grit.

Low Level A.

		Ft.	in.
No. 62	Fine grit	10	0
	Soft sandstone	6	0
	Blaze	3	0
	COAL	6	0
	Shale	4	0
		29	0

Dip, E. 10°.

Low Level B.

		Ft.	in.
No. 63	Fine grit	12	0
	Soft sandstone	2	0
	Blaze	1	0
	COAL	12	0
	Shale	2	0
		29	0

Dip, W. 10°; resting upon soft white sandstone.

		Ft.	in.
No. 64	COAL	12	0

Dip, W. 12°

No. 65—COAL, 3 feet shown on surface.
No. 66—COAL, top seam, 3 feet shown.

		Ft.	in.
No. 67	Soft sandstone	2	0
	Blaze	2	0
	COAL	3	0
		7	0

Dip, S. 12°.

High Level B.

		Ft.	in.
No. 68	Fine quartz grit	8	0
	Soft sandstone, with shaly partings	10	0
	Blaze	4	0
	COAL	18	0
	Shale	6	0
	Soft grey stone	10	0
		56	0

Dip, E. 10°; resting upon coarse grit.

No. 69		Ft.	in.
	Surface		
	Fine grit	30	0
	Soft brown to yellow sandstone	20	0
	Soft sandstone, with shaly partings	4	0
	Blaze	3	0
	COAL	18	0
	Shale	5	0
	Soft brown sandstone	10	0
	Coarse grit	15	0
		105	0

Dip, E. 10°; resting upon coarse grit.

No. 70		Ft.	in.
	Surface		
	Fine grit	20	0
	Soft brown to yellow sandstone	15	0
	Soft sandstone, with coaly partings	4	0
	Blaze	4	0
	COAL	14	0
	Soft dark sandstone	10	0
	Coarse grit	12	0
	Slate		
		79	0

Dip, E. 10°.

No. 71		Ft.	in.
	Surface		
	Fine grit	10	0
	Soft brown to yellow sandstone	5	0
	Soft sandstone, with coaly partings	3	0
	Blaze	2	0
	COAL	8	0
	Soft dark sandstone	6	0
	Coarse grit	6	0
		40	0

Dip, S.E. 12°; resting on slate.

No. 72		Ft.	in.
	Fine grit	20	0
	Soft sandstone	10	0
	COAL	20	0
		50	0

Dip, E. to S.E. 14°.

No. 73		Ft.	in.	Ft.	in.
	Surface				
	Fine grit			25	0
	Soft sandstone			20	0
	Blaze	4	0		
	COAL	26	0		
	Shale	2	0		
				32	0
				77	0

Dip, E. 14°.

Low Level D.

		Ft.	in.
No. 74	COAL, without roof	0	6
	Blaze	4	0
		4	6
	Dip, S. to S.E. 10°.		

		Ft.	in.	Ft.	in.
No. 75	Soft yellow sandstone			12	0
	COAL	2	0		
	Blaze	0	6		
	COAL	1	6		
				4	0
	Soft yellow sandstone, with shale partings			5	0
	Band of blaze			6	0
	Soft yellow sandstone, with shale			9	0
	COAL			20	0
	Blaze			2	0
				52	6
	Dip, S. to S.E. Resting upon hard grit.				

		Ft.	in.	Ft.	in.
No. 76	Soft fine grit			25	0
	Soft yellow sandstone			6	0
	Blaze	1	0		
	COAL	1	0		
				2	0
	Soft grit			18	0
	Soft yellow sandstone			10	0
	Blaze			6	0
	COAL, shown			12	0
				79	0
	Dip, S. to S.E. 12°.				

		Ft.	in.	Ft.	in.
No. 77	Surface				
	Fine grit			25	0
	Soft yellow sandstone			6	0
	Blaze	1	0		
	COAL	1	0		
				2	0
	Soft grit			20	0
	Soft yellow sandstone			6	0
	Blaze	8	0		
	COAL	32	0		
				40	0
				99	0
	Dip, S. to S.E. 8°.				

		Ft.	in.	Ft.	in.
No. 78	Alluvial wash - - - - - - -			3	0
	Brown marlstone, with ironstone nodules			30	0
	Soft fine grit - - - - - - -			6	0
	Soft yellow sandstone - - - -			6	0
	COAL - - - - - - - - -	0	8		
	Blaze - - - - - - - - -	1	0		
	COAL - - - - - - - - -	0	6		
				2	2
	Soft white sandstone, with dark partings -			23	0
	Blaze - - - - - - - - -	2	0		
	COAL - - - - - - - - -	1	6		
	Blaze band - - - - - - - -	1	0		
	COAL - - - - - - - - -	30	0		
				33	6
	Shale - - - - - - - - -			2	0
				105	8

Dip, S. to S.E. 20°.

		Ft.	in.
No. 79	Brown marl (shown) - - - - - -	20	0
	Fine grit - - - - - - - - -	12	0
	Soft yellow sandstone - - - - - -	8	0
	COAL (upper seam) - - - - - -	0	8
		40	8

Dip, S. 10°.

		Ft.	in.	Ft.	in.
No. 80	Surface - - - - - - - - -			1	0
	COAL - - - - - - - - -	0	4		
	Blaze - - - - - - - - -	2	0		
	COAL - - - - - - - - -	0	8		
				3	0
	Soft white sandstone - - - - -			60	0
	Yellow sandstone - - - - - -			30	0
	Blaze - - - - - - - - -			2	0
	COAL - - - - - - - - -			20	0
				115	0

Dip, S. 8°.

		Ft.	in.
No. 81	Soft white sandstone - - - - - -	60	0
	Yellow sandstone - - - - - - -	30	0
	Blaze - - - - - - - - - -	2	0
	COAL - - - - - - - - - -	10	0
		112	0

Dip, S. 10°.

		Ft.	in.	Ft.	in.
No. 82	Surface	2	0		
	Silt	3	0		
	Wash	3	0		
				8	0
	Brown marl, with fossil shell			50	0
	Fine grit			20	0
	Soft sandstone, with shaly partings			5	0
	Grit band			3	0
	Blaze	2	0		
	COAL	3	0		
				5	0
				96	0
	Dip, E. to N.E. 20°.				

High Level C.

		Ft.	in.
No. 83	Fine grit	20	0
	Fine soft sandstone	12	0
	COAL	20	0
		52	0
	Dip, S. 20°.		

		Ft.	in.
No. 84	Fine grit	12	0
	Soft sandstone	12	0
	COAL	8	0
	Shale	1	0
		33	0
	Dip, S., resting upon coarse grit.		

High Level D.

No. 85—Surface outcrops of coal 6 inches to 8 inches.

		Ft.	in.
No. 86	Fine grit	10	0
	Soft laminated sandstone	4	0
	COAL	6	0
		20	0
	Dip, S. to S.E. 10°.		

		Ft.	in.
No. 87	Surface	1	0
	Fine grit	9	0
	Soft sandstone (laminated)	5	0
	Blaze	2	0
	COAL	15	0
	Shale	2	0
		35	0
	Dip, S. to S.E. 10°, resting upon hard grit.		

		Ft.	in.
No. 88	Surface	1	0
	Fine grit	9	0
	Blaze	2	0
	COAL	10	0
	Shale	2	0
		29	0
	Dip, S.E. to S. 10°; resting upon hard quartz grit.		

Surface crops of COAL, varying from 4 feet, 6 feet, and 8 feet.

		Ft.	in.
No. 89	Surface		
	Fine grit	5	0
	Soft sandstone	3	0
	Blaze	3	0
	COAL shown	10	0
	Dip, S.W. to S.	22	0

		Ft.	in.
No. 90	Fine grit	4	0
	Soft sandstone	3	0
	Blaze	4	0
	COAL	8	0
	Dip, S. to S.W. 10°; resting upon hard grit.	19	0

		Ft.	in.
No. 91	Surface	1	0
	Fine grit	10	0
	Fine soft sandstone	8	0
	COAL	25	0
	Brown shalestone	6	0
	Dip, W. 10°; resting upon hard white grit.	50	0

		Ft.	in.
No. 92	Surface	1	0
	Blaze	3	0
	Fine grit	20	0
	Dark laminated sandstone	24	0
	Dip, S.W. 8°; resting upon hard red grit.	48	0

		Ft.	in.	Ft.	in.
No. 93	Sandy yellow grit			18	0
	Soft laminated sandstone	2	0		
	Sandy grit	1	6		
	Soft laminated sandstone	3	6		
	Dark sandstone	4	0		
	Bar of yellow sandstone	1	0		
				12	0
	Blaze			2	0
	COAL			25	0
	Dip, N.W. 15°; resting upon shale.			57	0

	Surface			Ft.	in.
No. 94	Yellow sandy grit			25	0
	Soft sandstone	1	0		
	Sandy grit	3	0		
	Soft sandstone	3	0		
	Dark sandstone	4	0		
	Hard yellow sandstone	3	0		
				14	0
	Blaze			1	0
	COAL			20	0
	Dip, N.W. 5°; judged as resting upon shale.			60	0

MID LEVEL E.

	Surface COAL	Ft.	in.
No. 95	White to yellow grit	25	0
	Soft dark sandstone	12	0
	Fine white grit	11	0
	Blaze	1	0
	Soft laminated sandstone	12	0
	COAL	40	0
		101	0
	Dip, S. to S.E. 10°; resting on a floor of dark standstone.		

	Surface	Ft.	in.	Ft.	in.
No. 96	COAL			1	0
	Shale			2	0
	Soft sandstone			2	0
	Fine grit			9	0
	Soft sandstone, with bars of grit			20	0
	Fine grit			16	0
	Fine sandstone			12	0
	Blaze	2	0		
	COAL	6	0		
				8	0
	Dip, S. to S.W. 15°; resting upon hard grit.			70	0

		Ft.	in.
No. 97	Fine grit	20	0
	Soft sandstone	5	0
	Fine quartz grit	3	0
	Fine sandstone	3	0
	Shale band	2	0
	COAL	3	0
	Dip, S. to S.W.; resting upon soft sandstone.	36	0

		Ft.	in.
No. 98	Fine grit	6	0
	Fine sandstone	4	0
	COAL	18	0
	Dark sandstone	10	0
	COAL (lower)	10	0
	Dip, S.E. 5° ; resting upon hard grit.	48	0

		Ft.	in.
No. 99	Surface		
	Fine sandstone	4	0
	Fine grit	20	0
	Fine sandstone (laminated)	8	0
	COAL	17	0
	Dip, N.E. to E.	49	0

Yellow Bluff.

		Ft.	in.
No. 100	Fine sandstone	15	0
	Blaze	1	0
	Fine sandstone	10	0
	Fine grit	10	0
	COAL	8	0
	Yellow sandstone	15	0
	Soft brown stone	16	0
	Soft yellow sandstone	20	0
	COAL	4	0
	Dip, S. to S.E. 10°; resting on slate.	99	0

MOUNT WILLIAM RIDGE.

		Ft.	in.	Ft.	in.
No. 101	Hard white grit			12	0
	Shale	2	0		
	COAL (blind)	6	0		
	Shale	4	0		
				12	0
	Dip, S.W. 10°; resting on coarse hard grit.			24	0

		Ft.	in.
No. 102	Surface		
	Fine quartz grit	10	0
	Fine sandstone	2	0
	COAL (lower)	6	0
		18	0
	Dip, S. 10°; resting upon grey sandstone.		

		Ft.	in.	Ft.	in.
No. 103	Surface				
	Fine white grit			10	0
	Soft sandstone (laminated)			12	0
	COAL	2	0		
	Blaze	1	0		
	COAL	1	0		
				4	0
	Soft dark sandstone (laminated)			8	0
	Fine grit	12	0		
	Bar of soft sandstone	4	0		
	Fine grit	14	0		
	Fine sandstone	6	0		
				36	0
	COAL			30	0
	Dip, N. to N.E., 10°.			100	0

		Ft.	in.
No. 104	Surface		
	Fine grit	30	0
	Soft sandstone	12	0
	Soft fine grit	30	0
	Blaze	4	0
	Soft sandy grit	30	0
	Soft laminated sandstone	12	0
	COAL shown	6	0
		124	0
	Dip, N. to N.E. 10°.		

No. 105—Same as No. 104.

		Ft.	in.	Ft.	in.
No. 106	Surface				
	Fine grit	24	0		
	Soft sandstone	6	0		
				30	0
	Blaze, with bands of coal			3	0
	Black stone			25	0
	Fine grit			4	0
	Soft laminated sandstone			4	0
	Red grit			10	0
	Blaze	14	0		
	COAL	40	0		
				54	0
	Fine grey sandstone			6	0
				142	0
	Dip, N. to N.E. 10°.				

		Ft.	in.	Ft.	in.
No. 107	Surface				
	Fine grit			35	0
	Blaze	8	0		
	COAL	1	0		
	Blaze	10	0		
	COAL	1	0		
	Blaze	1	6		
				20	6
	Laminated sandstone			12	0
	Fine red grit			6	0
	Blaze	8	0		
	COAL	2	0		
	Blaze	20	0		
				30	0
	Wedge of stone	2	0		
	COAL	3	0		
	Shale	2	0		
				7	0
	Hard grit			15	0
	COAL			4	0
				129	6
	Dip, N.W.; resting upon coarse grit.				

		Ft.	in.	Ft.	in.
No. 108	Surface				
	Fine grit			24	0
	Soft laminated sandstone			6	0
	COAL			6	0
	Blaze			10	0
	Soft laminated sandstone			30	0
	Fine grit			3	0
	Blaze	1	0		
	COAL	0	3		
				1	3
	Soft brown sandstone			25	0
	Soft yellow sandstone			10	0
	Blaze	4	0		
	Fine brown sandstone	20	0		
				24	0
	COAL	2	0		
	Blaze	2	0		
				4	0
				143	3

Dip, W. 15°; resting upon soft brown sandstone.

COALBROOK DALE.

		Ft.	in.
No. 109	Broken fine grit	10	0
	Sandstone	3	0
	COAL	2	0
	Bluish grit	12	0
	Dip, S. to S.E.; resting upon slate.	27	0

		Ft.	in.
No. 110	Broken grit	10	0
	Soft sandstone	3	0
	COAL	2	0
	Grit, grey	12	0
	Dip, S. to S.E.; resting on slate.	27	0

		Ft.	in.	Ft.	in.
No. 111	Surface	2	0		
	Soft red grit	20	0		
				22	0
	Soft sandstone			30	0
	Fine white grit			10	0
	Soft yellow sandstone			8	0
	COAL	0	3		
	Blaze	0	3		
	Band of sandstone	0	6		
	COAL	2	0		
	Shale	1	0		
	COAL	1	0		
				5	6
	Soft dark sandstone			10	6
	Coarse grit			10	0
	Dip, N. to N.E. 10°; resting on slate.			96	0

Upper Drive.

	Surface	Ft.	in.	Ft.	in.
No. 112	Fine grit			16	0
	Laminated sandstone			6	0
	COAL	9	6		
	Blaze	0	6		
	Band of stone	1	0		
	Blaze	7	0		
	COAL	1	6		
	Shale	0	6		
	COAL	1	0		
				21	0
				43	0
	Dip, W. 12°.				

	Surface	Ft.	in.	Ft.	in.
No. 113	Fine grit			8	0
	Soft laminated sandstone			10	0
	COAL	6	0		
	Shale	3	0		
				9	0
	Soft brown to grey stone			20	0
				47	0
	Dip, S.W. 15°; resting upon slate.				

	Surface	Ft.	in.	Ft.	in.
No. 114	Fine grit			20	0
	Soft sandstone (laminated)			20	0
	COAL	7	0		
	Blaze	5	0		
	COAL	2	0		
				14	0
				44	0
	Dip, S. to S.W. 10°; resting upon shale.				

		Ft.	in.
No. 115	Fine grit	20	0
	Soft sandstone (laminated)	25	0
	Fine grit	15	0
	Soft sandstone (laminated)	20	0
	Fire clay	0	3
	COAL	8	0
		88	3
	Dip, S. 15°.		

		Ft.	in.	Ft.	in.
No. 116	Fine quartz grit	7	0		
	Band of fine sandstone	0	6		
	Band of fine quartz grit	0	6		
	Fine sandstone	1	6		
	Fine quartz grit	4	0		
	Carried forward			13	6

		Ft.	in.
No. 116 *ontinued.*	*Brought forward*	13	6
	Fine red to white sandstone	5	0
	Fine sandstone	3	0
	Fine white quartz grit	4	0
	Dark sandstone	3	6
	Fine red sandstone	12	0
	Fine quartz grit	5	6
	Fine sandstone	8	0
	Fine red sandstone	6	0
	COAL	3	0
	Dip, S. 10°.	63	6

		Ft.	in.
No. 117	Fine white grit	25	0
	Dark soft sandstone (laminated)	8	0
	COAL	30	0
	Soft sandstone (laminated)		
	Dip, E. to N.E.; resting upon coarse grit.	63	0

		Ft.	in.	Ft.	in.
No. 118	Surface			2	0
	Red grit			20	0
	Soft sandstone			30	0
	Fine grit			10	0
	Soft yellow sandstone			8	0
	COAL	0	3		
	Blaze	0	3		
	Band of stone	0	6		
	COAL	2	0		
	Shale	1	0		
	COAL	1	0		
				5	0
	Soft dark sandstone			10	6
	Coarse grit			10	0
	Dip, N. to N.E.; resting upon slate.			95	6

No. 119—Same as No. 118.

		Ft.	in.	Ft.	in.
No. 120	Surface	2	0		
	Soft red grit	20	0		
				22	0
	Soft sandstone			25	0
	Fine grit			4	0
	Soft sandstone (yellow)			8	0
	COAL	6	6		
	Band of blaze	1	0		
	COAL	1	6		
				9	0
	Soft grey dark grit			20	0
	Dip, N. to N.E. 20°; resting upon slate.			88	0

Lower Drive.

		Ft.	in.	Ft.	in.
No. 121	Fine grit			20	0
	Soft dark brown sandstone			12	0
	Band of blaze			2	0
	Soft dark sandstone			6	0
	Fire clay			0	3
	COAL	8	6		
	Band of blaze	2	0		
	COAL	2	3		
				12	9
	Grey sandstone			20	0
				73	0

		Ft.	in.
No. 122	Surface		
	Fine grit	20	0
	Soft sandstone	20	0
	COAL	14	0
		54	0

Dip, S.W. 10°; resting upon blaze in bed of creek.

Edge of Cascade Break.

		Ft.	in.
No. 123	Fine grit	12	0
	Dark sandstone	10	0
	Blaze	3	0
	Sandy grit	15	0
	COAL	16	0
		56	0

Dip, N.E. 10°; resting upon grey sandstone.

		Ft.	in.
No. 123*a*	Fine grit	12	0
	Dark sandstone	10	0
	Blaze	3	0
	Sandy grit	15	0
	COAL	16	0
		56	0

		Ft.	in.
No. 123*b*	Fine grit (sandy)	8	0
	Soft fine sandstone	4	0
	COAL	5	0
	Dark sandstone	20	0
	Soft yellow sandstone	14	0
	COAL	18	0
		69	0

Dip, N. to N.E. 10°; resting upon dark grey stone.

High Level (Rochfort).

No. 124—Loose masses of COAL showing in head waters of River Whareatea.

		Ft.	in.
No. 125	Soft sandstone	12	0
	COAL	18	0
	Shale	4	0
	Coarse grit	20	0
	Dip, N.E.; resting upon slate.	45	0

		Ft.	in.
No. 126	Grey sandstone	14	0
	Blaze	6	0
	COAL	3	0
	Blaze	5	0
	Soft grey sandstone	10	0
	Dip, N.E.	38	0

		Ft.	in.
No. 127	Fine grit	12	0
	Soft sandstone	4	0
	Dark sandstone	6	0
	Band of grit	0	6
	Dark sandstone	1	0
	Band of grit	0	6
	Dark sandstone	1	0
	Fine grit	2	0
	Soft laminated sandstone	2	6
	Blaze	2	6
	Dark sandstone	12	0
	Blaze	4	0
	COAL	1	0
	Blaze	8	0
	Dip, N.E. 18°.	45	0

		Ft.	in.
No. 128	Soft sandstone	10	0
	Blaze	4	0
	COAL	0	6
	Blaze	8	0
	Dark sandstone	12	0
	Dip, N.E. 12°.	34	6

No. 129—Same as No. 130.

		Ft.	in.
No. 130	Surface	1	0
	Blaze	3	0
	Fine grit	20	0
	Dark laminated sandstone	24	0
		48	0
	Dip, N.W. 8°; resting upon fine grit at water level.		

		Ft.	in.
No. 131	Fine grit - - - - - - - - -	20	0
	Soft dark sandstone- - - - - - -	15	0
	Blaze - - - - - - - - - -	4	0
	COAL (upper) - - - - - - -	1	0
	Shale - - - - - - - - - -	5	0
		45	0

Dip, N.W. 11°; resting upon dark sandstone.

		Ft.	in.
No. 132	Fine grit- - - - - - - - -	20	0
	Soft sandstone (red)- - - - - - -	10	0
	Dark laminated sandstone - - - -	1	0
	Blaze - - - - - - - - - -	3	0
		34	0

Dip, N. 18°.

		Ft.	in.
No. 133	Surface		
	Blaze - - - - - - - - - -	2	0
	Fine grit- - - - - - - - -	30	0
	Soft sandstone- - - - - - - -	20	0
	COAL (lower)- - - - - - - -	6	0
	Dark shalestone - - - - - - - -	10	0
		78	0

Dip irregular, but general tendency northwards.

PLATEAU (ROCHFORT).

No. 134—COAL in west bank of the Whareatea River. Upper measures same as No. 133.

	Ft.	in.
COAL - - - - - - - - -	1	6

Dip, N. to N.W.

Face of Plateau.

		Ft.	in.
No. 135	White quartz grit - - - - - - -	20	0
	Blaze - - - - - - - - - -	6	0
	COAL - - - - - - - - - -	3	0
	Shale - - - - - - - - - -	8	0
	Sandy grit - - - - - - - - -	20	0
	Blaze - - - - - - - - - -	5	0
	Soft sandy grit- - - - - - -	30	0
	Shale - - - - - - - - - -	2	0
	Coarse hard grit - - - - - - -	120	0
	Blaze - - - - - - - - - -	4	0
	Coarse hard grit - - - - - - -	35	0
	Band of blaze - - - - - - - -	2	0
		255	0

Dip, W. 15°; resting upon coarse quartz grit.

		Ft.	in.	Ft.	in.
No. 136	Soft sandy grit			28	0
	Blaze			2	0
	Grit			4	0
	Blaze parting			4	0
	Soft sandstone (laminated)			30	0
	Band of grit			4	0
	Soft red sandstone			20	0
	Blaze	1	0		
	Band of grit	1	0		
	Blaze	1	0		
	COAL	0	6		
	Blaze	0	6		
				4	0
	Soft dark sandstone			18	0
	Soft red grit			18	0
	Band of dark sandstone			10	0
	Quartz grit	0	9		
	COAL	0	3		
	Blaze	2	0		
				3	0
	Hard grit			12	0
	Blaze			4	0
	Coarse hard grit			24	0
	Coarse sandstone (breccia)			40	0
	Dip, N.W. 12°; resting on slate.			241	0

		Ft.	in.
No. 137	Fine quartz grit	50	0
	Blaze, with bands of stone	10	0
	COAL	4	0
	Dark shalestone	8	0
	Dip, W. 15°.	72	0

		Ft.	in.
No. 138	Blaze	1	6
	Sandy grit	25	0
	Blaze	1	0
	Red grit	30	0
	Blaze	1	0
	Fine to coarse grit	20	0
	Blaze	3	0
	Dip, W. 15°.	81	6

No. 139	Fine grit			25	0
	Coarse band of grit			6	0
	Fine grit			6	0
	Blaze	3	0		
	COAL	1	0		
	Blaze	2	0		
				6	0
	Dip, W. 20°; resting upon loose travelled grits.			43	0

	Summit of Mount Rochfort.	Ft.	in.	Ft.	in.
No. 140	Pebbly grits			60	0
	Sandy grits			10	0
	Blaze	2	0		
	COAL	1	0		
	Blaze	12	0		
				15	0
	Soft grit stone			10	0
	Blaze			2	0
	Fine grit			20	0
	Pebbly grits			31	0
	Fine grit			26	0
	Blaze			10	0
	Fine grit			32	0
	Coaly matter			4	0
				220	0
	Dip, W. to N.W. 12°; resting upon soft reddish sandstone.				
No. 141	Blaze			1	6
	Sandy grit			25	0
	Blaze			1	0
	Red sandy grit			30	0
	Coarse grit			30	0
	Blaze			1	0
	Fine grit			80	0
	Blaze			3	0
	Dip, W. 39°.			179	6
No. 142	Crushed COAL			3	0
	Dark brown sandstone			14	0
	Soft red sandstone			12	0
	COAL			2	0
				31	0
No. 143	Brown clay	Ft.	in.	Ft.	in.
	Marlstone				
	Grit			20	0
	Blaze			2	0
	Soft sandstone			4	0
	COAL and blaze			1	0
	Fine grit			20	0
	Dark sandstone			80	0
	Band of grit	6	0		
	Sandstone	8	0		
				14	0
	COAL	1	0		
	Blaze	1	0		
				2	0
	Grey grit			30	0
	Blaze			4	0
	Fine grit			35	0
	Dark sandstone			40	0
	Dip, W. 40°.			253	0

No. 144—Loose COAL showing on sidling.

No. 145—COAL showing; opened on by trench for about 5 chains; soft and sooty. Crops of section No. 146.

		Ft.	in.	Ft.	in.
No. 146	Surface			3	0
	Fine grit			10	0
	Blaze			1	0
	COAL	1	0		
	Blaze	1	0		
	COAL (bruised)	6	0		
				8	0
	Dip, W. 50°; resting upon dark shale.			22	0

Roche's Drive. Ft. in.

No. 147—Drive entered in the coal S.W. for about 200 feet.

COAL (crushed) - - - - - - - 18 0

Dip, W. 40°. Drive entered by Sims and party. Course, E. 10° S.

Sims', or Mulholland's Drive.

		Ft.	in.	Ft.	in.
No. 148	Dark soft sandstone			90	0
	Fine grit and sandstone (shook)			80	0
	Dark sandstone			60	0
	COAL (upper)			0	6
	Dark broken grit			40	0
	Shale	2	0		
	Shale and broken stone	40	0		
	Shale	4	0		
				46	0
	Dip, W. 60°.				
	Shale and sandstone (shook)	20	0		
	Shale	2	0		
	Dark sandstone	4	0		
				26	0
				345	0

Dip, E. 70°. This drive has since been extended 120 feet, cutting the coal, soft and blind, 18 feet thick.

No. 149—Outcrops of COAL, exposed by trench; showing crushed and sooty.

No. 150—Outcrops of COAL showing in Stoney, or Rewei Creek; no thickness obtained; shows soft and sooty.

		Ft.	in.
No. 151	Hard sandy grit	3	0
	COAL	1	0
	Shale	10	0
	COAL	1	0
	Shale	2	0
	COAL	1	0
		18	0

Dip, E. 50°. The above measures show to be much crushed, and the coal blind.

Organ's Coal.

		Ft.	in.
No. 152	Clay marl	30	0
	Soft sandy grit	8	0
	COAL	30	0
		68	0
	Dip, W. 50°.		

Sims' Spur.

No. 153—COAL trench opened in sidling, facing the Waimongaroa River, exposing loose crushed COAL, similar in thickness to No. 154.

		Ft.	in.
No. 154	Surface—loose broken blaze	2	0
	COAL (crushed)	12	0
	Blaze	1	0
	COAL, broken and crushed, mixed with bands of blaze and shale	35	0
		50	0
	Dip, N. 20°.		

		Ft.	in.	Ft.	in.
No. 155	Surface			3	0
	Soft dark sandstone			6	0
	COAL (good)	16	0		
	Blaze, with thin bands of COAL	10	0		
	COAL (soft)	4	0		
				30	0
	Soft brown sandstone			35	0
				74	0
	Dip, N.W. 30°.				

		Ft.	in.	Ft.	in.
No. 156	Blaze			10	0
	COAL (good)	15	0		
	Blaze, with bands of COAL	14	0		
	COAL (soft)	16	0		
				45	0
	Shale			2	0
				57	0
	Dip, N.W. 25°.				

		Ft.	in.
No. 157	Blaze		
	COAL	16	0
	Shale, holding COAL bands	14	0
	COAL (soft)	16	0
		46	0
	Dip, N. 20°.		

No. 158—Loose COAL observed in bed of small creek; country generally indicating a denuded area above, and this is only a remnant.

TODEA (CASCADE) AREA.

		Ft.	in.	Ft.	in.
No. 159	Surface				
	Fine grit - - - - - - -			35	0
	Soft dark sandstone (laminated) - -			6	0
	Dark sandstone, bordering upon blaze -			4	0
	Blaze and COAL - - - - - -	1	0		
	COAL (lower)- - - - - - -	2	0		
				3	0
	Dark sandstone - - - - - -			3	0
	Grey sandstone - - - - - -			2	0
	Coarse hard grit - - - - -			20	0
	Slate showing to bed of creek - - -			220	0
				293	0
	Dip, S. to S.E. 5°.				

		Ft.	in.
No. 160	—Showing same covering as Section No. 159.		
	COAL (lower)- - - - - - -	8	0

		Ft.	in.
No. 161	Surface		
	COAL (lower) shown - - - - - -	20	0
	Coarse hard grit - - - - - - -	45	0
	Slate to bed of creek - - - - - -	40	0
		105	0
	Dip, S. to S.E. 15°.		

		Ft.	in.
No. 162	Fine sandstone with dark partings - - -	8	0
	Fine sandstone and grit (mixed) - - -	30	0
	Dark laminated sandstone - - - -	10	0
	COAL (lower)- - - - - - - -	20	0
	Coarse grey shalestone - - - - -	10	0
	Soft hard grit, resembling sandstone breccia -	80	0
	Slate to bed of creek - - - - - -	140	0
		298	0
	Dip, S. to S.E. 10°.		

		Ft.	in.
No. 163	Fine sandy grit - - - - - - -	60	0
	COAL - - - - - - - - - -	40	0
	Coarse sandstone breccia- - - - -	100	0
	Slate to bed of creek - - - - - -	60	0
		260	0
	Dip, S. to S.E. 15°.		

		Ft.	in.
No. 164	Fine sandstone - - - - - - -	30	0
	Fine sandstone (laminated) - - - -	4	0
	COAL (lower)- - - - - - -	40	0
		74	0
	Dip, S. to S.E. 10°.		

		Ft.	in.
No. 165—Same as No. 166.			
	COAL	20	0

Dip, S. to S.E. 15°.

		Ft.	in.
No. 166	Fine yellow sandstone	50	0
	Laminated sandstone	1	0
	COAL (lower)	20	0
	Coarse hard grit	20	0
		91	0

Horizontal.

		Ft.	in.
No. 167	Surface		
	COAL (lower)	30	0
	Hard grit	25	0
	Schist to bed of creek	45	0
		100	0

Dip, N. to N.E. 15°.

		Ft.	in.
No. 168	Surface		
	Sandstone	12	0
	COAL (lower)	25	0
	Schist to bed of creek	732	0
		769	0

Dip, N. to N.E.

Shelf (East) Bank.

		Ft.	in.
No. 169	Fine yellow sandstone	30	0
	COAL showing above water	3	0
		33	0

TIO (ORIKAKA) VALLEY.

		Ft.	in.
No. 170	Dark laminated sandstone	4	0
	COAL (upper)	6	0
		10	0

Dip, N. 15°.

		Ft.	in.
No. 171	Soft sandstone (laminated), yellow	10	0
	COAL (lower)	25	0
		35	0

Dip, N. to N.W. 15°; resting upon grey shale.

		Ft.	in.
No. 172	Soft yellow sandstone	10	0
	COAL (lower)	4	0
	Soft sandstone	8	0
		22	0

Dip, N.W. 8°.

		Ft.	in.
No. 173	Soft yellow sandstone - - - - - -	20	0
	COAL (lower)- - - - - - - -	8	0
		28	0
	Dip, N. to N.W. 5°.		

North from Island Hill.

		Ft.	in.
No. 174	Surface		
	COAL (lower) shown - - - - - -	10	0
	Soft sandstone- - - - - - - -	12	0
	Coarse hard grit		
		22	0
	Dip, E. 8°.		

West Base of Island Hill.

		Ft.	in.
No. 175	Cemented gravel and brown marlstone - -	350	0
	Grey to brown soft sandstone, containing fossil oysters - - - - - - - -	30	0
	Soft band of blue shalestone - - - -	1	0
	COAL (upper) - - - - - - -	1	0
		382	0
	Dip, E. 15°.		

		Ft.	in.
No. 176	Soft laminated sandstone- - - - - -	15	0
	COAL - - - - - - - - - -	8	0
		22	0
	Dip, N.E. 15°.		

No. 177—COAL showing in small creek at base of Mount William Ridge, evidently a continuance of section No. 176.

No. 178—COAL showing in sidling of small spur in valley, about opposite peg No. 7 of M.N. Line, apparently solid; thickness not obtained. Dip, N.E. 15° (judged).

No. 179—COAL showing in main north branch of Divide Creek, west side of valley; showing in bed of creek for some distance, evidently thick, and part of section No. 2. No dip could be obtained.

No. 179*a*—COAL showing in bed of main north branch of Divide Creek, west side of valley; showing in bed of creek for some distance; evidently thick.

No. 180—COAL showing exposed on surface of Long Green Hill, north of divide; in valley, *lower seam*, east from section No. 171. Thickness exposed, 20 feet. Dip, E.; would judge from floor to dip about 10°.

No. 181—COAL near peg 7 of H. 20 line, in bed of small creek under H. 22.

	Ft.	in.
COAL shown - - - - - - - - -	4	0
Dip, N.E.		

No. 182—COAL showing on surface and sidling of spur, pegs 12–17 of H. 20 line, Mount William Ridge, evidently a remnant of denudation.

Dip, N. to N.E.

	Surface	Ft.	in.
No. 183	Band of blaze - - - - - - - - -	0	6
	Shalestone - - - - - - - - -	1	0
	COAL - - - - - - - - - -	6	0
		7	6

Dip, N.E. to E. 2°.

	Surface	Ft.	in.
No. 184	Soft brown laminated sandstone - - -	10	0
	Band of blaze - - - - - - - - -	2	0
	Soft to hard sandstone - - - - - -	30	0
		42	0

Dip, N.E. to E. 5°.

MOKIHINUI SHED.

Upper (Page's) Creek.

	COAL in upper part of Page's Creek	Ft.	in.
No. 185	Surface		
	Soft sandstone - - - - - - - - -	8	0
	COAL - - - - - - - - - -	2	0
	Band of sandstone - - - - - - -	3	0
	COAL - - - - - - - - - -	3	0
	Soft grey sandstone to water level - - -	4	0
		20	0

Dip, W. 5°.

Coal Creek.

	Surface	Ft.	in.
No. 186	Soft Sandy grit - - - - - - - -	8	0
	COAL shown to water level - - - - -	10	0
		18	0

Dip, N. to N.E. 10°.

Coal Creek.

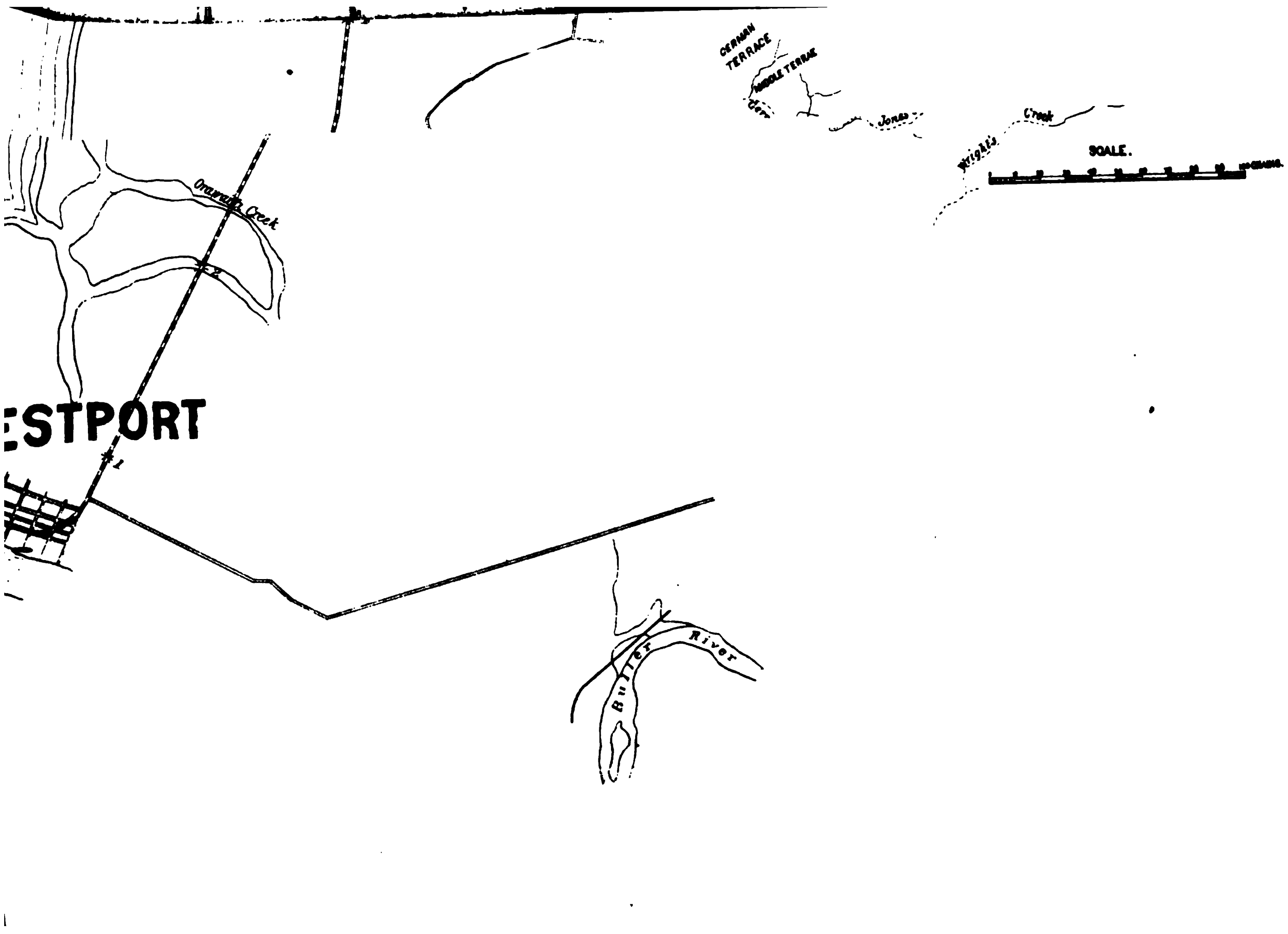
	Surface	Ft.	in.
No. 187	Soft sandstone (shown) - - - - - -	20	0
	COAL shown to water level - - - - -	18	0
		38	0

Dip, N. 10°.

Coal Creek.

	Surface (clay)	Ft.	in.
No. 188	COAL shown - - - - - - - - -	2	0
	Dark laminated sandstone - - - - -	1	0
	Dark brown sandstone to water level - -	3	0
		6	0

Dip, E. 18°.


GERMAN TERRACE
MIDDLE TERRACE
Jones
Wright's Creek
SCALE.
CHAINS.
Orowaiti Creek
#2
ESTPORT
#1
Buller River

Seaton's Drive.

				Ft.	in.
No. 189	Sandy grit			30	0
	Laminated sandstone			4	0
	COAL	4	0		
	Shale band	3	0		
	COAL	2	0		
				9	0
				43	0
	Dip, N.W. 8°.				

Page's Creek.

No. 190—COAL outcrops exposed along banks of Page's Creek, and continuance of Section No. 189.

	Ft.	in.
COAL	1	6

Dip, N.W.

West Bank Page's Creek.

Trench on west side of reef trend.

				Ft.	in.
No. 191	Soft laminated sandstone shown			4	0
	COAL	4	0		
	Shale band	2	0		
				6	0
	Soft shalestone			4	0
				14	0
	Dip, N.W., 5°; resting upon coarse hard grits.				

West Side Roche's Creek.

		Ft.	in.
No. 192	COAL showing in tunnel, about 10 chains back, south from Mokihinui River, west from Page's Creek.		
	Soft gritstone	20	0
	Soft sandstone	3	0
	COAL shown	3	0
		26	0
	Dip, N.W.		

West Branch Page's Creek.

No. 193—Travelled loose COAL showing along bed of small tributary of Page's Creek; measures generally showing solid, though no face of coal shown. Dip, N.W.

No. 194—Loose COAL showing in bed of small creek, in average-sized pieces; no solid face exposed.

Salt-Water Creek.

No. 195—Loose COAL showing exposed in bed of Salt-Water Creek, about 40 chains up from Mokihinui River; grits here showing broken, indicating a slip from the heights. Dip, N.W.

REPORT ON KAIKOURA PENINSULA AND AMURI BLUFF.

BY ALEXANDER McKAY.

To accompany Maps and Measured Sections.

Wellington, 16th March, 1876.

Memorandum for Mr. McKay by Mr. Mantell.

You will proceed to Amuri, *viâ* Kaikoura, and there make as extensive a collection as practicable, especially of Saurian remains. Make the best arrangements in your power for a sufficient supply of cases, paper, and other packing material, for the preservation of specimens. These can be forwarded to you, either to Kaikoura, or, by way of Lyttelton, to Amuri, if opportunity thence offers. It may be worth while to commence your collections at and to the north of Kaikoura, as, while doing this, you will be able to communicate with me, and receive replies, by telegram to that place. Report your arrival there, and give me information of your movements from time to time.

Copy of Telegram to Mr. McKay from Mr. Mantell.

Wellington, 6th April, 1876.

Amuri Bluff Series.—Make a measured section if possible, noting particularly what Saurians and other fossils you get above and below pebble or grit bed, especially what Saurians in lower formation.

In compliance with the foregoing instructions, I left Wellington for Kaikoura on the 16th March, where I arrived on the following day, and where, until the 20th, I was employed in the neighbourhood of the Kaikoura Peninsula.

On the 20th and 21st I examined the river bed of, and explored the sections along, the course of the Hapuka River as far as its source. Thence, returning to Kaikoura, I made some further examination of the peninsula, and prepared to proceed to the Amuri Bluff, for which place I started on the 24th, arriving at Oaro Creek the same evening. The following day was wet, and on the 26th March I was employed examining various localities, to determine what prospect existed of making a good collection. From then until the

2nd of April I was engaged in collecting from the western wing of the Amuri group, at the mouth of the Mikinui Creek; from the flinty beds of the Amuri limestone, on the coast north of Mikinui Creek, between that and Oaro Creek, up the latter creek for a mile above the junction of the two main streams, as well as on the ridges and in the creeks lying to the south as far as the Okariha Creek—a work of some difficulty, as the weather at that time was unfavourable.

On the 3rd of April I went to Amuri Bluff to make arrangements for the landing of packing material forwarded from Wellington, and, after a delay of two more days, which I employed collecting from the western wing, I succeeded in getting it landed on the 6th, which day, as well as the 7th April, I employed my time in making boxes and packing part of the collection already made at the mouth of the Mikinui Creek. I then removed from Oaro Creek to Amuri Bluff, for the purpose of collecting from the eastern wing of the Waipara formation.

On the 9th April I collected from the concretionary green sands (east wing) shells, etc., and the next day Saurian remains from boulders on the beach, and on the 12th collected Saurian remains from the north-east face of the Bluff. From the 13th to the 17th April I was engaged in measuring the different sections and making collections to illustrate the same. On the 17th April I found it necessary to go to Kaikoura for various requirements for the proper collecting of Saurian remains. I returned on the 19th, and, from then until the 23rd, examined different lo calities for Saurians, and also with a view to making out the sequence of the beds.

On the 24th April, while searching for Saurian remains, I discovered recent shell beds on the top of Amuri Bluff Hill, and was engaged collecting from these and packing the collection made, as well as other specimens, until the 28th April, when I commenced the extraction of Saurian remains by means of blasting, at which work I was employed until the 9th May, when I closed the cases at the mouth of the Mikinui Creek. I resumed work on the 10th May, and steadily continued till the 17th May, when, for the next few days, at the mouth of the Mikinui Creek, I collected Saurian remains, etc., the state of the tide preventing work being carried on along the north-east face of the bluff; but, on the 21st, I was again enabled to work on the east side, which I continued to do, with trifling interruptions, till the 31st of May.

From the 1st to the 6th of June I was engaged in making and getting together shell collections from the Amuri group (east wing), and, on the arrival of packing material, I employed my time in box-making and packing till the 17th, with an occasional interruption when a good specimen was discovered. On the 17th June it again became necessary to go to Kaikoura, from which place I returned on the 20th, and from then till leaving Amuri Bluff, on the 9th July, I was engaged packing collections and making such examinations as were necessary to complete the sections, etc.

I arrived at Lyttelton on the 10th July, and left for Wellington on the 11th, arriving here on the 12th, after an absence of 119 days, bringing with me 130 cases of specimens and 23 blocks of stone containing Saurian and other fossil remains.

KAIKOURA PENINSULA.

The result of several days' examination of this neighbourhood has served to show that rocks, elsewhere exceedingly rich in fossils, are here comparatively devoid of these interesting relics. The upper *Leda* beds, or grey marls, equally well seen on the north and south sides of the peninsula, if we except large *Fucoid* impressions and a few microscopic shells, may be said to be unfossiliferous.

The Amuri Limestone produced no better results, although sharks' teeth and other fossils are reported as occurring in the rock. The *Teredo* limestone is also present, and is easily recognisable, both from its position and its character, which are similar to the bed so called at Amuri Bluff. This rock also proved unfossiliferous.

Saurian Beds.—From the sandy clays of the higher part of these beds a few small fossils were obtained. Concretionary boulders, though not absent in these beds, are much smaller than at Amuri Bluff, and invariably contain neither fossil bones nor shells. These beds seem to be the lowest of the Waipara formation here exposed, the Amuri group, as developed at Amuri Bluff, being entirely absent, if the occurrence of a single boulder, having a few broken shells and in character resembling the black grit, be excepted.

The Putataka Beds, unconformably underlying the Saurian beds, proved also unfossiliferous, so that the collection obtained here was very small indeed. The geology of the peninsula is simple, consisting of a denuded anticline exposing, near the middle of the peninsula, the Putataka beds, overlaid unconformably by the different members of the Waipara formation, from the Saurian to the upper *Leda* beds, which, with the Amuri limestone, form a syncline between Port Kaikoura and the eastern end of the peninsula. To the west of the anticline, the

Amuri limestone seems to be the highest rock present, the *Leda* beds nowhere making their appearance in this direction.

The sketch map and section will serve to show the area over which the different rocks are exposed, and their sequence in section.

HAPUKA RIVER.

From the northern boundary of the Kaikoura Plain a narrow strip of the Waipara formation extends as far as the watershed dividing the creeks falling into the Clarence, from the source of the Hapuka River, having the Looker-on Mountains to the west, and the coast range south of the Clarence River to the east.

The Waipara beds lying between these mountain masses form a long narrow ridge, gradually attaining a higher elevation as it is followed north, till, at the source of the waters flowing north and south, it reaches a height of about 3,000 feet. From a distance it can be observed that Amuri limestone, dipping west, forms the crown of this ridge, and that the Saurian beds are necessarily exposed on the lower part of its eastern slope. On closer examination of the country, the idea of reaching the Saurian beds in this direction was abandoned, on account of the rough character of the ground to be passed over, and an examination of the sections exposed along the banks of the Hapuka River preferred. On reaching the bed of this river, where the track leading north crosses it, large spherical concretions of a brown colour are of a frequent occurrence among the larger blocks brought down by the stream. These, from their resemblance to the Saurian concretions, were examined, but in none of them were fossil remains detected; but *Belemnites* and fragments of *Inoceramus* shells were detected in a coarse brownish sandstone, of which considerable quantities were strewn over the shingle bed of the rivers, and this led to a hope that further up the river these rocks might be reached. A little better than a mile from the sea the river divides into two branches, the branch leading to the north entering the hills at this point, and from here throughout its course exposing a continued section.

The first rock seen consisted of grey sandstones, with beds of dark coloured shales, in which abundance of plant remains were seen, but so broken and indistinct that nothing recognisable could be obtained. Boulders similar in character to those occurring in the Putataka beds at Kaikoura were also observed at this point, striking east and west, with a low dip to the north. Following up the bed of the river, the sandstones soon attain a much higher angle, and strike more in a north-east and south-west direction, forming a high rocky bluff on the east bank of the river. One mile and a half from the point first observed, the ridge of hills formed by these rocks strikes away to the north-east, a low saddle dividing them from the rock seen higher up the river, and here, at the most important point, the junction cannot be seen.

The next rock observed is a coarse grey sandstone, with beds of black shales between, exposed as a reef striking across the river bed in a north-east and south-west direction. In these sandstones *Inoceramus* shells, mostly broken, were of frequent occurrence. They were succeeded, in ascending order, by dark micaceous sandy clays with small concretions, in which no fossils could be found. These were in turn succeded by fully 20 feet of a peculiar rock, consisting of flinty nodules in a matrix of dark shale; then followed the Amuri limestone, striking S. 40° W., with a dip to the N.W. of 75°, forming a high and very narrow gorge nearly a quarter of a mile in length. At its upper surface, the Amuri limestone is followed by the *Leda* beds, in which *Nummulities* and a few other small fossils are found, the same lying at as high an angle as, and comfortably upon, the upper surface of the limestone. For some distance the course of the river coincides more with the strike of these rocks, but eventually turns more to the west, cutting through them at an angle, and again exposing the Amuri limestone, here *distinctly overlying* the *Leda* beds, and striking N. 10° W., with a dip to the W. of 75°. For some distance from the Amuri limestone, the *Leda* beds are in a highly indurated condition, in comparison with that which they usually present. Upwards (in reality downwards) they can be traced till they assume something like their ordinary condition. On passing the narrow gap formed by this second occurrence of the Amuri limestone, which is here of far less thickness than in the lower gorge, the river (not now deserving to be called more than a creek) conforms in its course to the strike of the limestone, which forms the western slope of the range, through which the river cuts in between the two limestone gorges. All doubts, as to the reality of this part of the section representing an overturned syncline, were dispelled on observing the same bed of flinty nodules described as underlying the Amuri limestone at the first gorge, here, at this point, overlying the Amuri limestone, and in turn succeeded by Saurian beds identical in character with those further down the river. The Putataka beds were also present here, but apparently not in an overturned condition, their dip being at a high angle to the east. They consisted

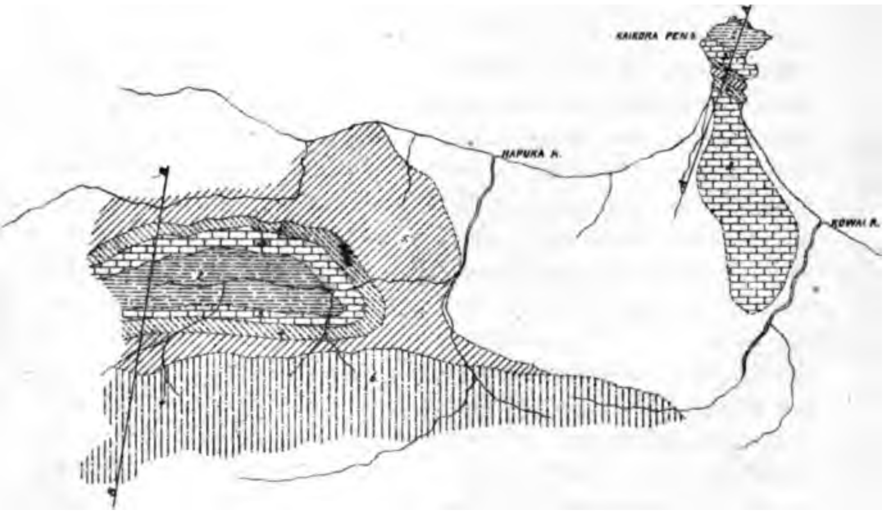
Geological Survey of New Zealand.

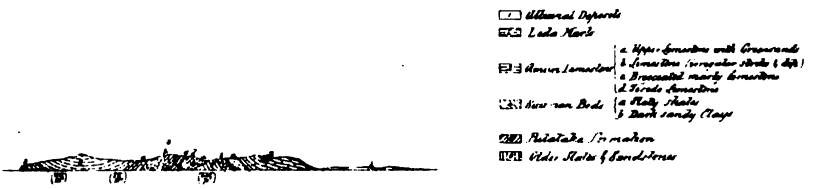
JAMES HECTOR, M.D., F.R.S., DIRECTOR.

To illustrate Report by A. McKAY. April 6, 1876.

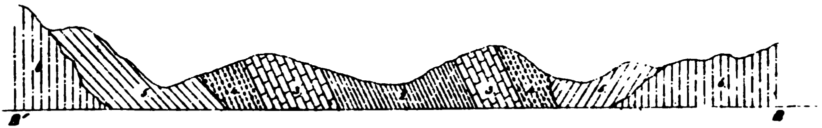
KAIKORA PENINSULAR

GEOLOGICAL MAP & SECTIONS





SECTION AA KAIKORA PENINSULAR



SECTION BB - HAPUKA RIVER

at this point of coarse green sandstone with coarse pebbly grits. Of fossils, nothing was to be found which offered an inducement to make collections in a place so unfavourable with reference to the facilties of transit, and so, with the exception of a few rock specimens, no collection was made.

The accompanying map and section show the position and sequence of the different beds as observed, and is interesting as showing the great amount of disturbance to which *Leda* marls have been subjected in what must be considered as comparatively recent times, the amount of disturbance taken into consideration.

AMURI BLUFF.

The Waipara formation here is confined to a rectangular block of country, bounded, on the east, by the coast line between the mouth of the Conway River and the Amuri Bluff; on the north, by the north-east face of the bluff and the coast line as far as the mouth of Oaro Creek; on the west, by the Oaro Creek to its source, and thence by a line continued to the Conway River, which forms the southern boundary to the sea. The block so bounded does not include a greater area than twelve square miles, and over not more than half of it are Waipara rocks to be found, their greatest mass being north of the Okariha Creek, and their best exposure along the north-east face of the bluff. Attention here was paid principally to this northern part of the district under review, and, over and above the large collections made, a coloured map and five measured sections have been constructed, coloured so as to distinguish between the *Leda* marls and Amuri limestone of the chalk group; between the *Teredo* limestone and green sand forming the upper beds of the green sand group, and the lower (or Saurian) beds of the same; and, in the Amuri group, between the black grit (upper), grey sandstone (middle), and the calcareous conglomerate (lower).

Recent gravels, rising in successive terraces and in some parts rich in fossils, cover the whole of the coast line between the the mouth of the Conway River and the Okariha Creek, north of which they overlie nearly the whole of the *Leda* marls on the eastern side of the anticline. It is on the third and highest terrace, now in great part destroyed, where these beds have proved to be fossiliferous; and on the top of Amuri Bluff Hill, in their lower part, they consist almost entirely of a shell conglomerate mixed with boulders derived from the underlying rock in the immediate vicinity. Their elevation is here 500 feet above the sea level; their total thickness, 10 feet or 12 feet. On the lower terraces their thickness varies from 25 feet to fully 30 feet. North of Okariha Creek, they nowhere seem to be present to the westward of the anticline which divides the Waipara formation into what, for convenience, may be called the eastern and western wings.

Adopting the classification already proposed by Dr. Hector,* the following table shows the further division of the different beds of either group, having reference only to the various horizons from which fossils were collected, these minuter subdivisions being shown neither on the map nor on the accompanying sections :—

I. Chalk group	*Leda* marls *Fucoidal* limestone Flaggy " Cherty " Grey " Chalk marl	Upper *Leda* beds. Green sands. *Fucoid* beds. Calcareous green sand. Green sand conglomerate. *Fucoidal* limestone. Flaggy " Marly " Flinty " Lower "
II. Greensand group	*Teredo* limestone Green sands Concretionary green sands Boulder sands Sulphur sands	*Teredo* limestone. Green sands. Grey sandstone. Lower *Teredo* limestone. Concretionary green sands. Lower Saurian beds.
III. Amuri group	Black grit Grey sandstone Calcareous conglomerate	Black grit Green sands. Grey sands. Lower black grit. *Aphorrhais* beds. *Tirgonia* beds. *Belemnite* beds. Lower, or wood sands.
IV. Jurassic group	Green sandstones and shales.	Green sandstones and shales.

DESCRIPTION OF SECTIONS.

Section AA.

This section runs at right angles to the strike of the beds, and begins at the south bluff, thus taking in the greatest thickness of *Leda* marls exposed in the district, showing a total thickness of 630 feet; the upper part, one-half the entire thickness, being a light grey

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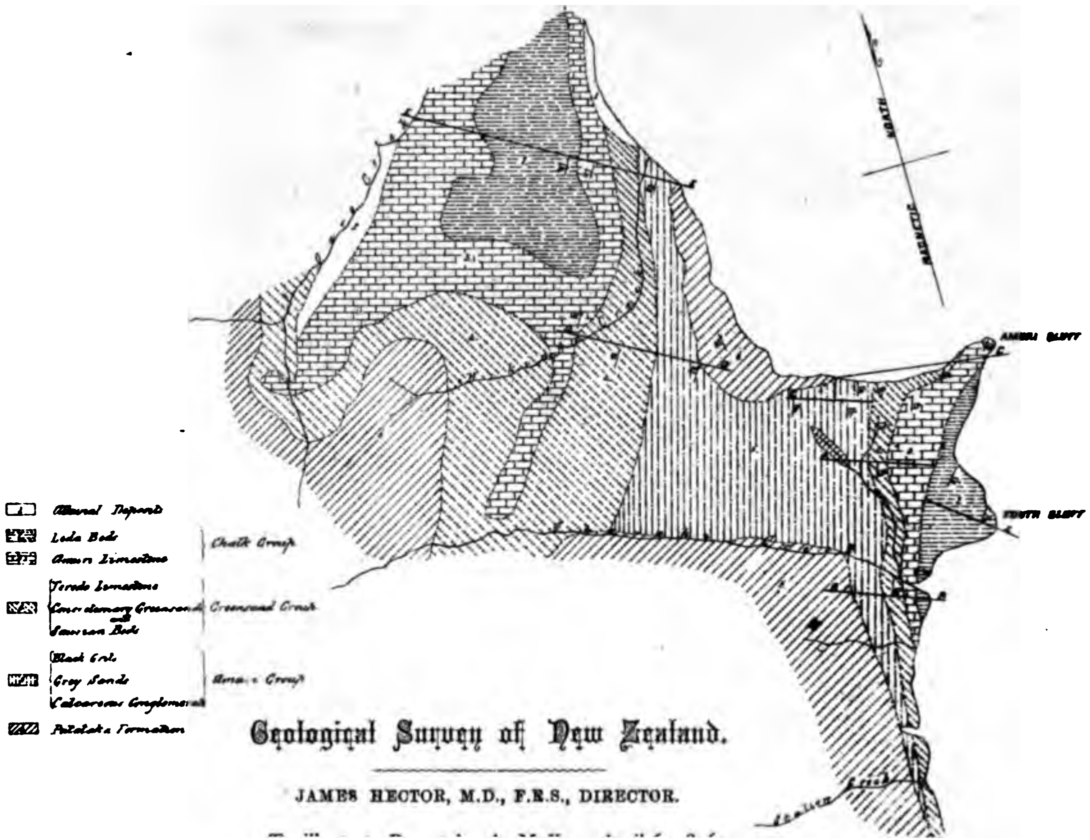
* Trans. N.Z. Inst., VI., 356.

GEOLOGICAL MAP OF AMURI BLUFF



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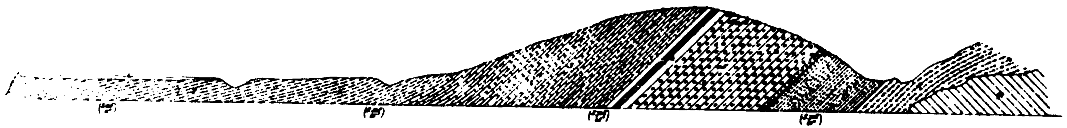
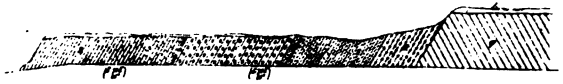
MEASURED SECTIONS AT AMURI BLUFF

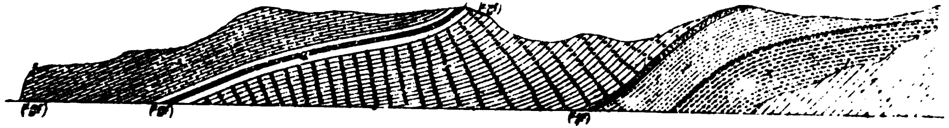
▭ Alluvial deposits
▨ [illegible]
▨ Amuri Limestone } Chalk Group
▨ [illegible]
▨ [illegible] } [illegible] Group
▨ Black Grit
▨ Grey Sands
▨ Calcareous Conglomerate } [illegible] Group
▨ [illegible] Formation



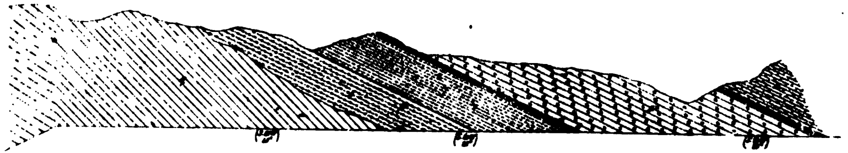
Section AA.



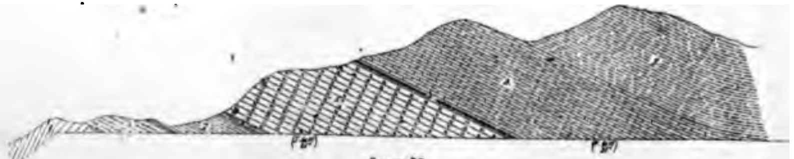
Section BB.



Section CC.



Section DD.



Section EE.

[illegible]

		Section AA.	Section BB.	Section CC.	Section DD.	Section EE.	[illegible]	[illegible]	[illegible]
Chalk Group	[illegible]	[illegible]	[illegible]			[illegible]			
	Amuri Limestone	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
[illegible] Group	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Group	Black Grit	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Grey Sands	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Calc. Conglomerate	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* Total thickness of beds does not appear

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To illustrate Report by A. McKAY. April 6, 1876.

sandy marl, containing none or but few fossils. The lower part, more varied in character, may be divided as follows :—

1. Marls, at first but slightly glauconitic, soon becoming so highly charged with that substance as to lay claim with propriety to the title of green sands.
2. Greenish marls, clearly stratified, and characterised by the great abundance and beauty of the *Fucoid* impressions which they contain.
3. A highly calcareous green sand, resembling, but much harder than, the calcareous green sand of the Weka Pass, Canterbury.
4. Green sand conglomerate. This, the lowest member of the *Leda* marls, is a most peculiar bed, consisting of nodules of a calcareous green sand in a matrix of green sand, and, although apparently incoherent, is often of extreme hardness.

This terminates this division of the chalk group, the Amuri limestone succeeding in descending order; but, although its upper and lower boundaries were made out in this section, none of the subdivisions elsewhere made could be distinguished. The total thickness of Amuri limestone on this line of section is 630 feet, considerably more than what shows in any other section; and, as the *Leda* marls are here also considerably thicker than elsewhere, this section shows the greatest development of the chalk group, which, taken together, gives a total thickness of 1,260 feet, being slightly more than half the entire thickness of the formation of which they form the highest division.

The lowest beds of the Amuri limestone crop out on the highest part of Amuri Bluff Hill, and the green sand group is exposed on the western slope of the same, the first division of which, the *Teredo* limestone (well seen 100 yards south of the line of section), is there about 20 feet thick, and followed by 15 feet of loose green sands, which, in turn, are underlaid by 45 feet, the whole forming a division quite distinct from the concretionary green sands which underlie, and are elsewhere parted from these by a bed of limestone, which, though differing in character from the upper *Teredo* limestone, may, from its association with this subdivision, be called the lower *Teredo* limestone.

These beds at this point have a total thickness of 80 feet, and are underlaid by the concretionary green sands, boulder sands, and gypseous or sulphur sands, representing the remaining divisions of the green sand group, and, from lack of clear exposure in section, here grouped together, having a total thickness of 450 feet, thus giving to the green sand group a total thickness of 530 feet, the upper surface of the black grit (the highest bed of the Amuri group) now being reached. The black grit here shows its average thickness of 20 feet, and is underlaid by yellowish brown sulphurous shales, elsewhere represented by differently coloured sands, green and grey, which have a thickness of 315 feet. From this point, the lower beds, including the calcareous conglomerate, have a thickness of 180 feet, which terminates the section, the Putataka beds making their appearance in the bed of the creek on this line of section, the Amuri group, to all appearance, not being fully represented here, the total thickness being 515 feet.

Section BB.

The strata was again measured along the south bank of Okariha Creek, where a level terrace 150 feet above the sea offered considerable advantages, although the subdivisions of the different groups are not here to be made out. Of the *Leda* marls, only the lower beds (360 feet thick) are preserved in this section. The Amuri limestone is here much thinner than in the other sections, having a thickness of 260 feet only. As elsewhere, this limestone is parted from the *Leda* marls by that most persistent of beds, the green sand conglomerate. Underlying the Amuri limestone, the *Teredo* limestone cannot, at its lower surface, be distinguished from the higher of the Saurian beds, the concretionary green sands, nor they, in turn, from the lower Saurian beds, the upper surface of the black grit being the first horizon identified after passing the upper surface of the *Teredo* limestone, and, allowing a thickness of 30 feet to this bed and the underlying green sand, the underlying concretionary green sands, boulder sands, and sulphur sands, to the upper surface of the black grit, have a thickness of 445 feet. On the north bank of the creek. black grit shows a thickness of 20 feet, and, as in this section its upper surface only is seen, its thickness (20 feet) has been deducted from the total thickness of the group, which shows a thickness of 585 feet, divided as follows:—

	Ft.	in.
Black grit	20	0
Grey sandstone	365	0
Calcareous conglomerate	200	0
	585	0

the boundary between the grey sandstone and the calcareous conglomerate being distinguished only by the outline of the surface. The lowest beds seen are crowded with *Trigonia*, from which it may be inferred that they are not the lowest beds of the series.

Section CC.

This section, measured along the north-east face of the bluff, from the upper surface of the Amuri limestone to the base of the Amuri group, though in places much obscured, is yet capable of minuter division of the beds than any of the others. The *Leda* marls are in greater part wanting, or exposed only below high-water mark, forming a series of reefs for some distance from the shore. A few feet of calcareous green sand (Weka Pass stone), with the thin bed of green sand conglomerate parting it from the Amuri limestone, cuts the brow of the cliff on the eastern sea face, underlaid by—

	Ft.	in.
Fucoidal limestone	27	6
Flaggy „	45	6
Marly „	93	4
Flinty „	38	5
Lower „	125	3
Giving a total thickness of ...	330	0

The *Teredo* limestone and associated beds, to the upper surface of the concretionary green sands, have a thickness of 81 feet, subdivided as follows:—

	Ft.	in.
Teredo limestone (upper)	3	0
Grey sand, with hard masses	4	3
Grey sand, weathering into bands ...	6	4
Loose green sands	4	3
Loose green sands, with chalky pebbles	3	2
Grey sands, with irregular concretions ...	48	0
Lower *Teredo* limestone	12	0
Total thickness	81	0

Concretionary green sands next succeed, which, to the upper surface of the boulder sands, have a thickness of 248 feet. The concretions throughout this division are much softer than in the underlying beds, and often contain a large percentage of vegetable matter in a broken-up condition. Between the boulder sands and the gypseous or sulphurous sands, only an arbitrary distinction could be made, their united thickness to the upper surface of the black grit being 352 feet.

We now come to the black grit, the highest member of the Amuri group, the upper and more characteristic part of which is on this line of section, 25 feet thick. Green sands, in places quite loose, underlie the black grits, and pass in their lower beds into grey sands with calcareous concretions. These sands, in their lower part, are much darker in colour, and are divided from the lighter grey and green sands by a bed of grit lighter in colour than the black grit, but otherwise very similar. The total thickness of these sands is 215 feet. Below these, highly fossiliferous sandstone and calcareous conglomerates form the lower beds of the group, having a thickness of 240 feet, the last bed seen being a conglomerate, 2 feet thick, overlaid by a coarse blue sandstone, both of these being characterised by abundance of *Belemnites*, other fossils being rare.

Section DD.

This section extends from the western slopes of Kais Hill, at right angles to the strike of the beds, to the *Teredo* limestone on the west side of the Mikinui Creek, together with section *EE*, shows the thickness and sequence of the Waipara formation west of the anticline (western wing). Taken in descending order, section *DD* shows Saurian beds (concretionary green sands, boulder sands, and gypseus or sulphur sands), having, to the upper surface of the black grit, a thickness of 485 feet, the details of these beds not being made out. Black grit, of a thickness of 20 feet, is next seen, forming the crown and western slope of a long narrow ridge, the eastern side of which, and western slopes of a corresponding ridge, are crowned by a bed of grit resembling the black grit in character, and with a thickness of 210 feet. These beds are underlaid by grey sands with masses of highly fossiliferous sandstone, of a thickness of 119 feet, at the base of which the *Belemnite* bed occurs. Then, underlying the *Belemnite* bed, we have in this section brownish grey sands of a thickness of 81 feet, which seem to be present in only this section and in section *EE*. From these lower sands comes the fossil wood, of which so much is to be found on the beach at the mouth of Mikinui Creek. These wood sands close the section, the Putataka beds now making their appearance, and forming Kais Hill to the east.

Section EE.

Measured along the coast from the junction of the Waipara formation with the Putataka beds, to the upper surface of the Amuri limestone (centre of the syncline on the coast, between the Mikinui and Oaro Creeks). Taken in descending order, the Amuri limestone shows a thickness of 430 feet, no attempt having been made to ascertain the thicknesses of the different subdivisions. *Teredo* limestone and green sands, 30 feet thick, underlie, and thence to the upper surface of the black grit the Saurian beds have a thickness of 500 feet, the different divisions of which are not apparent. The black grit forms a hard reef running out to sea, and is here about 20 feet thick. Grey sands to and including the lower grit, 180 feet, the remaining total of 160 feet representing the lower shell beds and wood sands, the first having a thickness of 74 feet, and the latter 86 feet, the line of separation being marked by the occurrence of the *Belemnite* bed. This closes the section, the Putataka beds here underlying.

Collections were made from the lower part of the *Leda* marls, on section *AA*. No collection was obtained from *BB* on this occasion, but on a former occasion a small collection was obtained from the *Leda* marls forming the sea cliffs on this line of section. From all the larger groups and subdivisions of *CC* important collections were obtained. From *DD* nothing was collected, but from the Amuri limestone (section *EE*) and the lower part of the Amuri group large collections were made.

In addition to the localities mentioned, a considerable collection was made from concretionary boulders of green sand from Oaro Creek, near the junction of the two main branches, the fossiliferous beds seeming to immediately underlie the Amuri limestone.

AMURI BLUFF.—TABLE SHOWING THICKNESSES OF BEDS IN VARIOUS SECTIONS.

	AA.	*BB.*	*CC.*	*DD.*	*EE.*	**Best Example.**
CHALK GROUP—	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
Leda marls	630	...	...	...	...	*AA*, 630
Amuri limestone ...	630	260	330	...	430	*CC*, 330
GREENSAND GROUP—						
Teredo limestone ...	80	30	81	...	30	*CC*, 81
Saurian beds	450	445	600	485	500	*EE*, 500
Black grit	20	20	25	20	20	*CC*, 25
AMURI GROUP—						
Grey sands	315	365	215	210	180	*DD*, 210
Calcar. conglomerates...	180	200	240	200	160	*DD*, 200
	2305	1320	1491	915	1320	Tl. 1976
CHALK GROUP	1260	...	...	...	...	
GREENSAND GROUP ...	530	475	681	485	530	
AMURI GROUP	495	585	480	430	360	

East of the anticline, the strike of the beds in the higher parts of sections *AA* and *CC* is 40° E. of N. At the black grit on *CC*, the strike is 5° E. of N., while in the lower part of the same section the strike is 20° E. of N. From the Amuri limestone to base of section *AA*, the strike is 20° E. of N. On sections *DD* and *EE*, there is a uniform strike of 30° to the W. of S., the dip being N.W. 25°. On the eastern wing, in section *AA*, the dip gradually increases from 15° at the higher surface of the *Leda* marls, to 45° at the base of the Amuri limestone, from which, to the base of the section, it remains at 45°. The *Leda* marls, where present, and the upper part of the Amuri limestone in section *CC*, dip to the S.E. at an angle of 25°. At the base of the limestone, and in the *Teredo* limestone, the dip is 23°. At the upper surface of the black grit it is not more than 17°, but near the base of the section it rises again to 23°. Strike and dip throughout the whole of the Saurian beds could not be obtained.

MEMORANDUM OF INSTSRUCTIONS FOR MR. McKAY,

BY DR. HECTOR.

October 9th, 1876.

You will take advantage of the projected visit of the "Luna," to Cape Campbell, which, I learn, will allow you four days to examine the country there.

The points I wish made out are as follows :—

1st. Are the Cape Campbell beds part of the Awatere series, as stated by Captain Hutton, or do they belong to the Upper Chalk and Greensand Group?

2nd. What is the base of the Awatere series in the district; and how is it bounded on the east?

3rd. At Flaxbourne I found that the sandstone described by Captain Hutton, as overlying the Amuri limestone, is really near the base of the Amuri series, and rests on a coarse breccia conglomerate, as seen in the high range N.W. of Flaxbourne station. This conglomerate in his section is also erroneously referred to the Awatere Group.

J. HECTOR.

REPORT ON CAPE CAMPBELL DISTRICT.

BY ALEXANDER McKAY.

11th October, 1876.

IN accordance with the above instructions I left for Cape Campbell on the evening of the 9th inst., arriving there early on the 10th, and immediately commenced to examine the surrounding country. After an hour spent in the neighbourhood of the Cape in search of fossils which might determine the age of the beds there exposed; and on the fog (which during the early morning had been dense) partially clearing away, I left the coast line and proceeded in a westerly direction across the strike of the beds, until the Amuri limestone was reached, at which point I made some careful observations as to the relations of the overlying beds.

From this point I proceeded south and west at an angle across the strike of the beds, crossing an exposure of the Greensand and Amuri Groups of the Waipara formation, and eventually encountering heavy conglomerates of a comparatively recent character. Having examined these at several points I next followed them in a northerly direction, observing that they rapidly thinned out and are not present at all on the coast line; the Awatere beds here making their appearance, and resting highly unconformably on the Greensand and Amuri Groups.

After an examination of the Amuri limestone, which at this point has a more easterly strike than is usual in the district, and terminates as a reef running out to sea, I returned along the beach, examining in the sea cliffs the overlying beds, and so returned to Cape Campbell.

The next day, the 11th, I followed the coast line from Cape Campbell south for a distance of six miles, and thence inland across the strike of the beds to Flaxbourne station; from which point I examined the Awatere beds forming low hills west of the Home station; thence south and east across the coast range, examining the beds in ascending order, till the Amuri limestone was reached, which I followed to the point where it crosses the Flaxbourne river; thence I examined the south bank of the river to the junction of the two main streams at the woolshed.

12th October.—In the morning I examined the range which terminates at the north bank of the Flaxbourne river, between the manager's residence and the woolshed, the same being separated from the limestone range to the east by a long deep gully having a north and south trend. This is in no wise connected with the spurs which slope from the limestone range on the south side of the river, its natural continuation being now the valley of the south branch of the Flaxbourne river, at present occupied by the Awatere beds; thence I followed the track and telegraph line to the northern end of the freshwater lake, near Flaxbourne; and thence across the downs to the large salt water lagoon, making partial examinations of the Awatere beds in this direction, and so returning to Cape Campbell by way of ground already passed over.

13th October.—I calculated on having yet another day for the purpose of making collections, at some points whence it seemed desirable such should be made, but the arrival of the Luna early in the day prevented my doing so, and leaving Cape Campbell about 10 a.m., I arrived in Wellington the same afternoon.

PHYSICAL GEOGRAPHY.

The district over which my examinations extended is about 12 miles in length (north and south) and not more than 6 miles in breadth; bounded on the north by the southern shore of Cook's Straits, on the east by the sea, on the south by an east and west line one mile south of the mouth of the Flaxbourne river, and on the west by a line parallel to the eastern boundary.

The features of the country are hilly, no ground north of the Flaxbourne river attaining a greater elevation than 1000 feet above sea level.

The ridges are mostly coincident with the strike of the beds, but yet are often cut by low saddles where no hard beds are inter-bedded with the softer rocks. On this account the soft sandy and marly beds in the neighbourhood of Cape Campbell form an assemblage of hills, having regular outlines, and which at first sight appear scattered promiscuously over the surface of the country, seldom attaining a height of more than 500 feet above the sea. These, however, on closer examination, range themselves in lines which follow the general strike of the beds, and are deeply cut into in one or two places by the larger water courses.

The Amuri limestone forms the watershed of the district, as defined above, broken through by one creek only, and with this exception forms a continuous ridge fully 700 feet in height, commencing at the sea, one mile east of the salt water lagoon, and continuing in a straight line till broken through by the Flaxbourne river.

West of the central limestone ridge the country, where formed of the older rocks, such as the Greensand and Amuri Groups, assumes a more rugged appearance, cliffs and projecting masses of rocks contrasting with the more regular outlines of the hills east of the limestone ridge.

The more westerly part of the district, chiefly owing to its rocks consisting of Awatere beds and terrace gravels, presents the appearance of rolling downs, with valleys of considerable breadth, compared with the size of the streams which flow through them.

GEOLOGY.

Considering the limited time at my disposal, I shall not be able to do more than give a general description of the different formations which occur in the district. Commencing with the oldest rocks seen—these are heavy beds of volcanic agglomerates, inter-stratified with beds of green sandstone, and commencing on the northern bank of the Flaxbourne river they are continuous to within a mile and a half of the sea, and if not cut off by the Awatere beds, would form the bar which separates the salt water lagoon from the sea.

Dark green sandstone and indurated shales overlie these beds, and are in places fossiliferous, Inoceramus being found as broken fragments, which, from the absence of plications on the shell seems to belong to the species which specially characterizes the black grit at Amuri Bluff; and the position of these beds in this section point them out on stratigraphical grounds as belonging to the same horizon. Overlying these are beds of green sandstone, with thick beds of rusty coloured shales, the sandstone ranging in colour from dark green to a light grey, with specks of green; the shales, though much more indurated than at the Amuri Bluff contain considerable numbers of concretionary boulders, many of them of respectable dimensions (on an average 2 feet 6 inches in diameter.) These are to be found in all the gullies south of the Flaxbourne river, and west of the limestone ridge, in the vicinity of Cape Campbell. The conclusion is therefore irresistable that these are the Saurian beds (the boulder sands and the lower part of the concretionary greensands). Overlying these—the Saurian beds—comes a very considerable thickness of greensands and flinty calcareous beds, often so concretionary as to resemble a conglomerate. Many of the sandstone beds are composed of coarse grains of quartz, with specks of green or other dark coloured mineral.*

The Amuri limestone next succeeds, often interstratified with beds of greensand, and abounding in flints of all colours—flesh coloured, black, and grey. All these beds strike nearly north and south, and dip at high angles to the east, except south of Flaxbourne, where heavy faults have considerably interfered with the regularity of the beds.

On the north bank of the Flaxbourne river the Amuri limestone, which to the northward strikes nearly north and south, and dips to the east, is here sharply turned round, and a little south of the river separates into two exposures; that nearest the coast line still continuing in a nearly north and south direction, while the westerly or inland out-crop strikes in a W.S.W. direction, for a distance of nearly a mile, and then gradually approximates to a north and south strike, the dip in both these divisions being easterly. Saurian beds are exposed to the west of the eastern division, and to the east, north, and west of the western one. It is clear, therefore, that we have here to do with a great fault, which reaching its maximum some distance to the south, gradually lessens in degree until on the south bank of the Flaxbourne river—the faulted portion again unites with the eastern or non-faulted portion of the beds. This will be more apparent in plan and section, but the above will serve to explain the sudden termination of the volcanic breccias on the north bank of the Flaxbourne River.

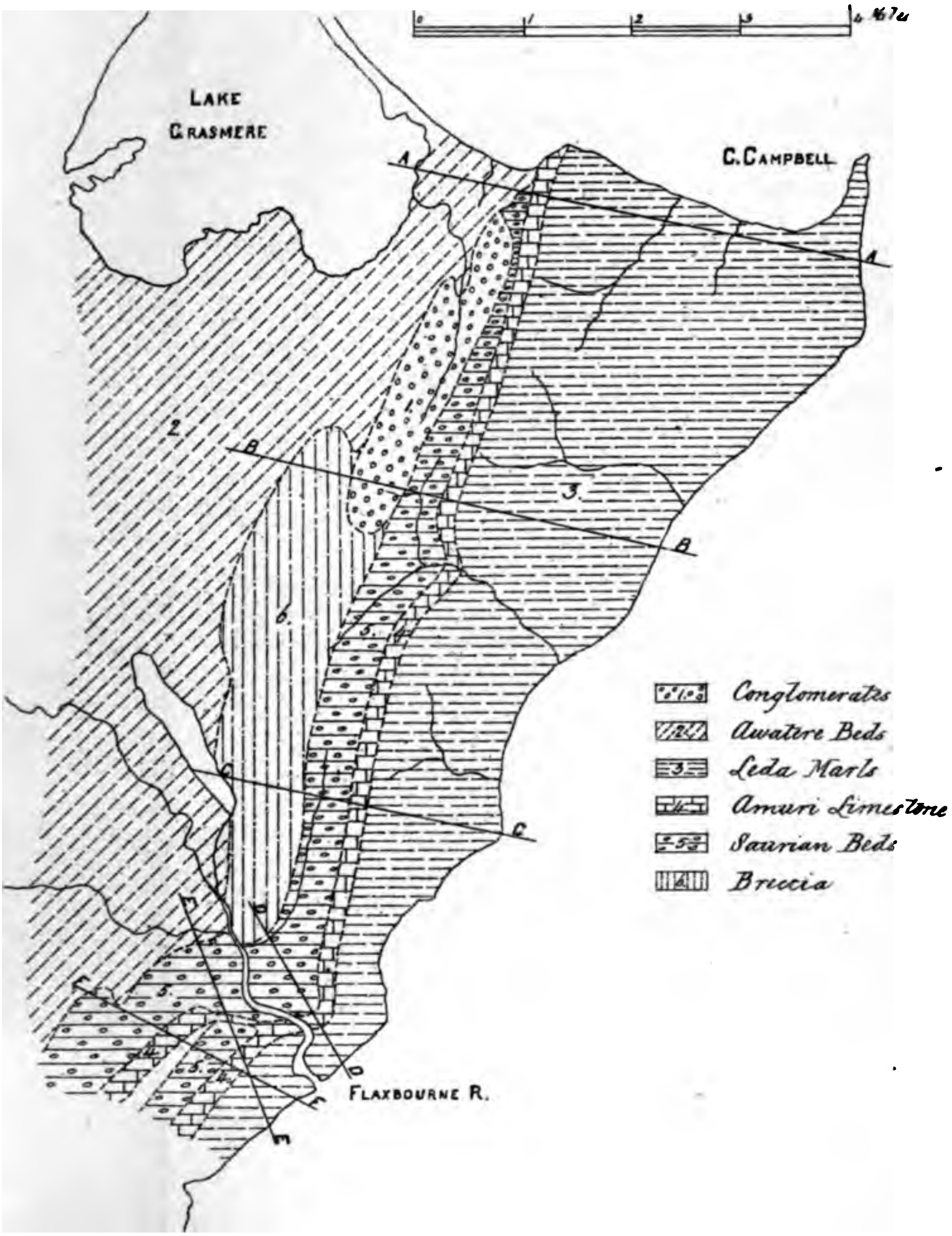
The next bed in conformable sequence I recognize as the Grey Marls occupying the whole of the country east of the limestone range, and here

Geological Survey of New Zealand.

JAMES HECTOR, M.D., F.R.S., DIRECTOR.

To illustrate Report by A. McKAY. October 11, 1876.

GEOLOGICAL MAP OF CAPE CAMPBELL



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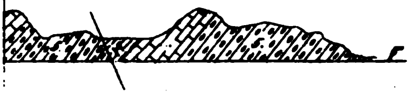

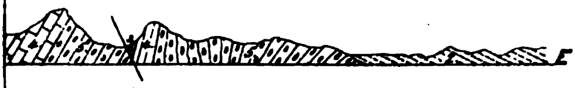

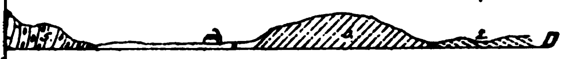

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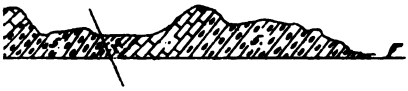

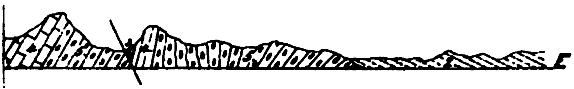

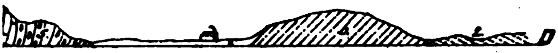

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developed to an enormous thickness probably not far short of 8000 feet. In their lower beds, immediately overlying the Amuri limestone, they are seen as beds of greensand, passing into grey sandy beds, standing at a high angle of from 55° to 60°. Higher in the section they are occasionally interstratified with thin beds of fine grained rock, resembling cement stone; near the middle, or perhaps in their higher beds, occur several beds of greensand, which are seen as such in the sea cliffs of the northern part of the district; but inland, where these have been long exposed to the influence of the atmosphere, they appear as beds of brown sandstone. Less than a mile from Cape Campbell the highest beds are reached, and from this point to the Cape the beds dip at high angles to the west. These beds are generally unfossiliferous, but will, I am satisfied, yield sufficient fossils for the purpose of their determination.

The few fossils which I obtained, were all of such types as characterise the Grey Marls elsewhere. Captain Hutton considers these Cape Campbell beds as belonging to the Awatere series. Before, therefore, giving other reasons than the above, I shall describe the Awatere beds as they occur in the district, and also show, from travelled blocks of the same, what is the character of the lowest beds of the same series outside the district under review.

Awatere Beds.—These are wholly confined to the western part of the district, and commencing at Flaxbourne, occupy the low ground west of the volcanic breccia beds, covering all the country west and north till within two miles of the sea, where they cut off the volcanic breccia, and rest on the upturned edges of the greensand group, near the sea, and coming in contact with the Amuri limestone. They dip at all points observed in a westerly direction, at angles from 35° to 45°. In character they closely resemble the higher portion of the Grey Marls, but are abundantly fossiliferous. They are nowhere found in contact with the Grey Marls, and consequently their relation to those beds cannot thus be determined, and, other facts not taken into consideration, it might be considered that these beds are nothing more than the beds intervening between Cape Campbell and the limestone ridge; but when it is considered that at all points the Grey Marls are strictly conformable to the Amuri limestone, and the latter in like manner to the underlying beds, and that the Grey Marls have fully participated in the original upheaval of the series to which they belong, it will be seen that no beds of the same age could possibly be unconformable in the degree which the Awatere beds are to the lower beds of the same series; and thus it appears, that whatever be the age of the soft sandy beds to the east and west of the Amuri limestone, they cannot possibly be of contemporaneous origin. It further appears from an examination of certain conglomerates in the same district, younger than either the Grey Marls or Awatere beds, that only the higher beds of the latter are developed in the district. In the conglomerates mentioned are included large blocks of a still older fossiliferous conglomerate, with abundance of Awatere fossils and pebbles of Amuri limestone and masses of shelly conglomerate—the chief fossil in these being a black oyster; the same beds also contain blocks of sandy limestone and fine grained sandstone, with abundance of Awatere fossils. The Amuri limestone must therefore have suffered considerable denudation prior to and during the deposition of the Awatere beds, which, in their lowest members, seem to include a variety of rocks, nowhere to be found east of the limestone ridge; so that despite a certain similarity between the beds east and west of the limestone ridge, those to the east, for reasons already given, both stratigraphical and palœontological, must be determined as the Grey Marls, and those to the west for like reasons as the Awatere beds.

The next beds which call for special notice are, as far as I have seen, confined to the central and northern part of the district. These are conglomerates, composed in chief part of well rounded boulders, but having a large per centage of angular blocks of great size, so that on the surface they often present the appearance of old Morainic accumulations. A great variety of rocks are represented in these conglomerates—old slates and sandstones, and even crystalline rocks from the inland ranges; volcanic rocks belonging to the Amuri group; green sandstone from the Saurian beds; and great masses of Amuri limestone—as before mentioned large boulders of conglomerate from the Awatere beds, as well as limestones, sandstones, and shell conglomerates belonging to the same. The whole of these beds cannot be less than 200 feet in thickness, and in places they rise to an elevation of 850 feet above the sea. These, like the Awatere beds, never pass eastward of the limestone range, nor are they seen west of the breccia beds; but, as they are but the remnants of a formation which must once have covered a considerable extent of country, other outliers of them will probably yet be found to the south and west.

Traces of them appear to be present on the shore of the south-east corner of the salt water lagoon, where large blocks of Amuri limestone and other older rocks are found, but these may be due to an extension of the Amuri rocks in this direction, covered in the intervening space by the Awatere beds.

The only other rocks in the district are recent deposits in the river valleys, and terraces skirting them, and call for no particular comment.

In conclusion, I may mention that at Cape Campbell, green sandstone and Amuri limestone are plentiful as shingle on the beach, leading to the belief, that the reef which there runs out to sea may in part be composed of these rocks, as these shingles do not find their way from the west, where these rocks crop out on the beach.

The explanation seems to be that they are swept down by the creeks, taking their rise in the limestone ridge, and, finding their way to the coast, are carried north till they find shelter on the north-west side of the Cape; and not that they are derived from reefs of Amuri limestone and underlying beds out to sea, as these could only occur at a considerable distance from the land. Occasional boulders of granitic crystalline rocks favour this theory of their being derived from the younger conglomerates immediately west of the Amuri limestone.

The following table shows the sequence of the beds occurring in the district, and their equivalents at Amuri Bluff:—

FLAXBOURNE AND CAPE CAMPBELL.	AMURI BLUFF.
1. Volcanic breccia and beds of green sandstone.	1. Belemnite and Trigonia beds.
2. Green sandstone and indurated shales.	2. Grey and greensands, black grit.
3. Gritty sandstones (often green), sandy shales with Saurian boulders.	3. Greensand Group, Boulder sands and Concretionary greensands.
4. Flinty beds with beds of green sand and white limestone.	4. Green sand, with upper and lower Teredo limestone.
5. White limestone, with beds of quartzose and green sandstone.	5. Amuri limestone, (upper, middle and lower.)
6. Greensands, passing into grey sands.	6. Calcareous green sands, or Weka Pass limestone.
7. Grey Marls.	7. Grey Marls.
8. Awatere beds.	8. Absent.
9. Coarse conglomerates.*	9. ,,

* The high level shelly conglomerates at Amuri Bluff may possibly be of the same age, but there is no evidence in support of this.

Geological Survey of New Zealand.

JAMES HECTOR, M.D., F.R.S.,
DIRECTOR.

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